POWER

Volume 63 New York, March 23, 1926 *No.* 12

Power-Plant Engineers' Wages

READ the letter from Carl F. Miller on page 460 of this issue, and then read this bid from the U. S. Civil Service Commissioners:

FIRST-CLASS STEAM-ELECTRIC ENGINEMAN

Receipt of applications for first-class steam-electric engineman will close April 17. The date for assembling of competitors will be stated on the admission cards sent applicants after the close of receipt of applications.

The examination is to fill vacancies in the Departmental Service, Washington, D. C., and in positions requiring similar qualifications.

The entrance salary is **$1,500** a year. After the probational period required by the civil service act and rules advancement in pay without material change in duties may be made to higher rates within the pay range for the grade, up to a maximum of **$1 860** a year. Promotion to higher grades may be made in accordance with the civil service rules as vacancies occur.

The duties are to have charge of the operation, maintenance and repair of a large heating, lighting and power plant, and all auxiliary mechanical and electrical devices and equipment.

Competitors will be rated on practical trade questions, and training and experience.

The principal organization of the stationary engineers starts off its constitution by saying:

This association shall at no time be used for the furtherance of strikes or in any way interfering between employer and employee.

The motto of its members is "To earn more learn more."

They like to feel that they are executives; heads of departments, responsible for keeping the works going, charged with their employer's interest and capable of taking care of it.

Some employers have appreciated this attitude. They treat their engineers as they do other department heads, hold them responsible for results and pay them accordingly.

Some do not.

The members of trades that are organized are getting more money for fewer hours work than the unorganized engineers who are hiring them.

If the engineer is swerved from his loyal and high-minded course, who is to blame?

Think it over, Mr. Employer!

F. R. Low

Effect of Use Upon the Steam Rate of Turbine-Generators

First-Hand Data from an Extended Study of Turbine Performance Over a Long Period

By STERLING S. SANFORD
The Detroit Edison Company, Detroit, Michigan

AN INTERESTING study has recently been made of the life history of a number of steam turbines installed in several central-station power plants to determine the effect of use and condition upon their steam rates. Several of the machines were installed previous to 1914 and one had been in service since 1909. Of the number studied, ten machines, ranging in capacity from 8,000 to 20,000 kw., had been in service and in good condition long enough to give a reliable indication of the increase in steam rate with use of the machine.

The average annual increase in steam rate of these ten machines was 0.16 lb. of steam per kilowatt-hour over an average period of 5.7 years. This corresponds to an average annual increase of 1.2 per cent of the guaranteed steam rate. The average annual increase in steam rate for the individual machines ranged from 0.11 to 0.25 lb. per kw.-hr. These values were encountered in properly maintained power plants and apply to machines in normal operating service. All the turbines were of the Curtis type, two of them being horizontal and the remainder being vertical machines. The

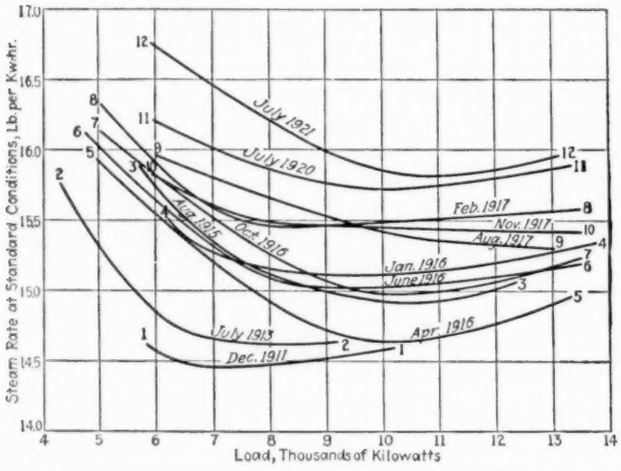


Fig. 1—Steam rate of a 14,000-kw. vertical turbine-generator over a period of ten years

average increase in steam rate for the horizontal units was slightly lower than for the vertical units.

Fig. 1 shows graphically the effect of use upon the steam rate of one of these turbine-generators. This figure shows the steam-rate curves for various tests on a 14,000-kw. vertical unit from December, 1911, to July, 1921. The tests are numbered in chronological order, and each curve is labeled with the date of the test. In each case the steam rate as determined by test has been corrected to standard conditions of steam pressure and temperature at the turbine throttle and pressure at the exhaust by using the correction factors furnished by the manufacturer. The standard conditions used were those for which the guarantee was made. The effect of variation in conditions at the

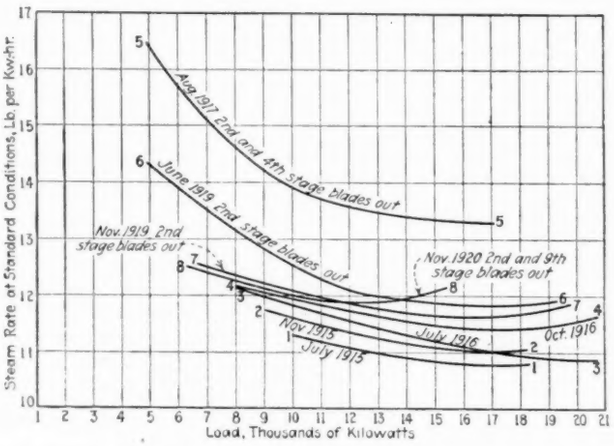

Steam Rate at Standard Conditions, Lb per Kw-hr.
Load, Thousands of Kilowatts
Aug. 1917 2nd and 4th stage blades out
June 1919 2nd stage blades out
Nov. 1919 2nd stage blades out
Nov. 1920 2nd and 9th stage blades out
Nov. 1913
July 1913
July 1916
Oct. 1916

Fig. 2—Steam rate of a 20,000-kw. horizontal machine with various bucket wheels removed

throttle and exhaust of the turbine thus eliminated, the variation in steam rate for different tests must be explained by changes in the internal condition of the turbine. It will be noted from Fig. 1 that the steam rate was lowest at the time of the first recorded test and highest at the time of the latest test of which there is record. The steam rate for intervening tests is not in every case progressively higher, but the trend is upward. The annual increase in steam rate for this unit was slightly less than the average for all the machines.

Fig. 2 shows what happens to the steam rate of a turbine-generator when accidents cause the removal of blades. The machine in this case is a 20,000-kw. horizontal 9-stage turbine-generator. The first four tests show the steam rate to increase gradually with use. An accident then caused the removal of the second- and fourth-stage blades with a resulting increase in steam rate from 11.4 to 13.3 lb. per kw.-hr. at the best point. The replacement of the fourth-stage blades decreased the steam rate to 11.7 lb. per kw.-hr. Another accident then necessitated the removal of the ninth-stage blades, thus decreasing the capacity of the unit. The steam rate at low loads did not seem to be affected by the removal of the ninth-stage blades, but at the higher loads it was again increased. This unit was not one of the machines for which the average annual increase

in steam rate was calculated, as the time elapsing between the first and last tests with the turbine intact was only slightly more than a year.

Fig. 3 shows the engine efficiency on the Rankine cycle at test conditions for the same turbine-generator as that of Fig. 2. In this case no correction has been made for variations in steam pressure and temperature at the

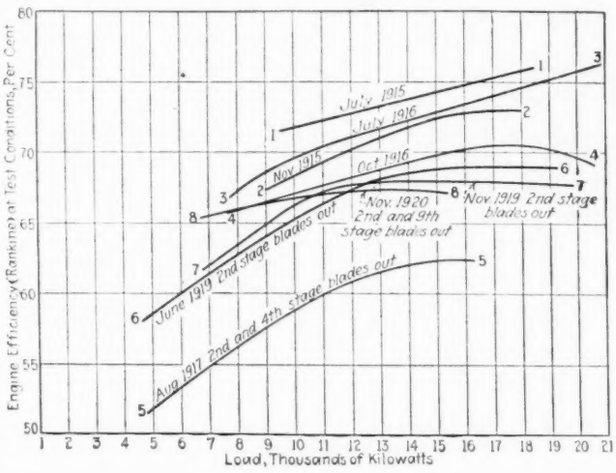

Engine Efficiency (Rankine) at Test Conditions, Per Cent
Load, Thousands of Kilowatts
July 1915
July 1916
Nov 1915
Oct 1916
Nov 1920 2nd and 9th stage blades out
Nov 1919 2nd stage blades out
June 1919 2nd stage blades out
Aug 1917 2nd and 4th stage blades out

Fig. 3—Engine efficiencies corresponding to the steam rates of Fig. 2

throttle or for pressure at the exhaust. Engine efficiency on the Rankine cycle is the ratio of the thermal efficiency of the actual engine to the thermal efficiency of the corresponding ideal engine.

Fig. 4 shows the engine efficiency on the Rankine cycle for the same turbine-generator at standard conditions. In this case the steam rate was corrected for variations in conditions at the throttle and exhaust before using it in computing the engine efficiency. A

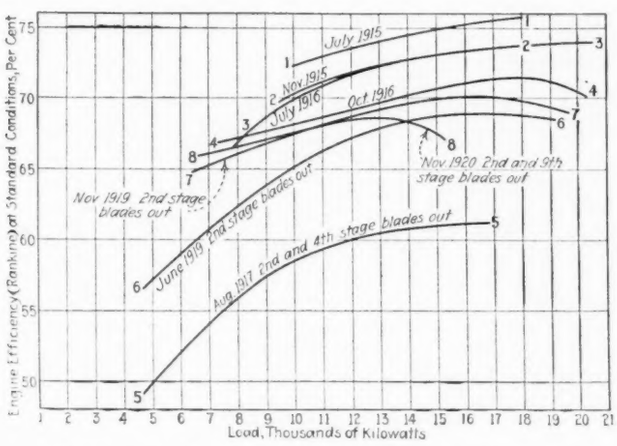

Engine Efficiency (Rankine) at Standard Conditions, Per Cent
Load, Thousands of Kilowatts
July 1915
Nov 1915
July 1916
Oct 1916
Nov 1920 2nd and 9th stage blades out
Nov 1919 2nd stage blades out
June 1919 2nd stage blades out
Aug 1917 2nd and 4th stage blades out

Fig. 4—Engine efficiencies of Fig. 3 reduced to standard conditions

comparison of Figs. 3 and 4 shows how engine efficiency varies with steam pressure and temperature and back pressure. Curves 2 and 3 have changed places, and curves 6 and 7 have also changed their relative positions. This demonstrates that it is not possible to correct the steam rate of a turbine-generator for variations in steam pressure and temperature and back pressure by assuming a constant engine efficiency on the Rankine cycle. Engine efficiency on the Rankine cycle decreases with increasing initial pressure and increases with increasing superheat and back pressure.

Fig. 5 shows how engine efficiency on the Rankine cycle increases with an increase in back pressure. These data are from a 45,000-kw. turbine-generator. Engine efficiency on the Rankine cycle corrected only for steam pressure and temperature at the throttle is plotted against pressure at the exhaust for three different loads. The tests from which the three points on each curve were obtained were made on three successive days, so that the effect of change in the mechanical condition of the turbine was eliminated. In each case the engine efficiency on the Rankine cycle increases with the back pressure. The same thing was found for every turbine-generator investigated. The explanation is that at low back pressures the volume of steam passing the exhaust

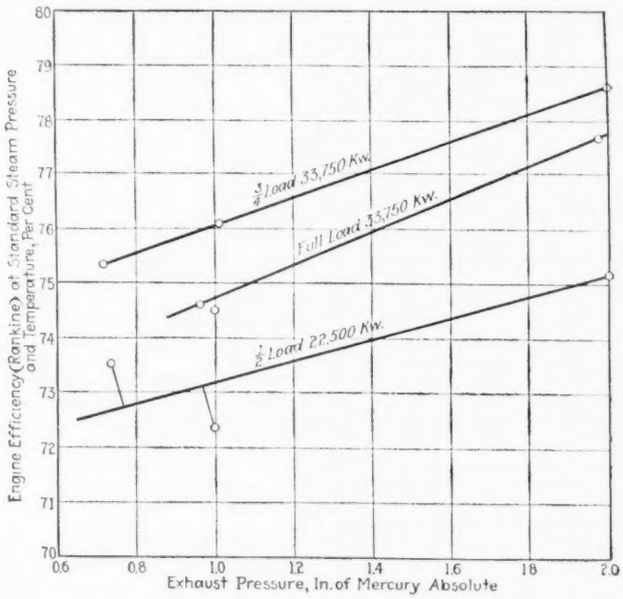

Engine Efficiency (Rankine) at Standard Steam Pressure and Temperature, Per Cent
Exhaust Pressure, In. of Mercury Absolute
¾ Load 33,750 Kw.
Full Load 33,750 Kw.
½ Load 22,500 Kw.

Fig. 5—Effect of exhaust pressure on the engine efficiency of a 45,000-kw. unit

end of the turbine is greater, so that there is more crowding of the steam.

Everyone knows of course that the steam rate of a turbine increases with an increase in back pressure, but few realize that the engine efficiency on the Rankine cycle also increases with back pressure. It should be remembered that engine efficiency on the Rankine cycle is a measure of the actual performance of a turbine compared with what it could do if it were a perfect machine working under ideal conditions within the same limits of pressure on the Rankine cycle. The fact that the engine efficiency is higher with high back pressures simply means that the turbine is able to take better advantage of the limits of pressure imposed upon it than it is at low back pressures.

It is well known that turbine buckets and nozzles deteriorate with use, notably through erosion by wet steam in the low-pressure stages, through the accumulation of scale and through accidental mechanical damage. Unfortunately, there is available little information whereby the influence of such deterioration may be accurately appraised in terms of economic performance. The data presented in this article are too scanty to support general conclusions, but are presented simply as a contribution to the information on this subject.

Two New Welding Discoveries

Employ

Atomic Hydrogen

Scientific research leads to a new process wherein a "flame" of atomic hydrogen (without oxygen) supplies heat for fusion welding. Heat comes from rushing together of hydrogen atoms after molecules have been split by blowing a gas jet through an electric arc. Another hydrogen-arc process, developed at the same time, operates on a different principle.

Man welding with a flame of atomic hydrogen

COMBUSTION, as ordinarily understood, implies two things: the uniting of a substance with oxygen and the rapid generation of intense heat. The second is sometimes taken to imply the first, but this is not necessarily the case. It has been discovered, for example, that a "flame" of intensely hot hydrogen can be produced without oxygen. This has been made the basis for a new system of fusion welding known as "atomic-hydrogen arc welding."

In this process, which has been developed chiefly by Dr. Irving Langmuir of the General Electric research laboratory at Schenectady, a jet of hydrogen is blown through an arc between two tungsten electrodes, changing much of the hydrogen from the molecular to the atomic form. That is, the two atoms of which each hydrogen molecule is composed are forced apart by the intense heat of the arc. In this separation the atoms absorb energy from the arc.

Moving out from the arc a certain distance, the atoms rush together to form molecules once more, the energy thus released producing an intensely hot hydrogen "flame" suitable for welding.

Experiments carried on with special torches built on this principle have produced welds for which consistent ductility is claimed, due, it is stated, to the bathing of the fused metal by the strongly reducing hydrogen atmosphere, which prevents the formation of oxides or intrudes of iron.

Simultaneously with the report of this development in the Schenectady laboratory comes the announcement of another hydrogen-arc welding process developed by the Thomson Laboratory, Lynn, Mass. This is described in the latter part of the present article.

The initial discovery that hydrogen changes from the molecular to the atomic state at high temperatures was made by Dr. Langmuir fifteen years ago while he was studying the loss of heat from incandescent tungsten filaments in an atmosphere of hydrogen gas.

A mathematical investigation showed that the heat carried away from the filament by the gas far exceeded what was possible by the ordinary processes of convection and conduction. Study suggested, and further experiment proved, that some of the hydrogen molecules split into atoms at the filament, soaking up large quantities of energy in the process, and then moved out, coming together again and releasing this heat.

Continuing the theoretical investigation, Dr. Langmuir found that more atomic hydrogen was formed by passing powerful electric arcs between tungsten electrodes at atmospheric pressure. By directing a jet of hydrogen from a small tube into the arc, the atomic hydrogen could be blown out of the arc, forming an intensely hot flame of atomic hydrogen burning to the molecular form. In this flame molybdenum, one of the most refractory of metals, melts with ease; quartz, however, melts less easily, in spite of its lower melting point. This indicates that the metal assists in the action as a catalyzer (scientists define a catalyzer as a substance which, by its mere presence, helps along a chemical change).

By this method it is claimed that iron can be welded or melted without contamination by carbon, oxygen or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chromium, aluminum, silicon or manganese are said to be welded without fluxes and without oxidation.

The technical development of this welding process has been the work of several men in the Schenectady laboratory, including R. A. Weinman and Robert Palmer. These men have developed many types of weld-

ing torches, and have tried them under varying conditions. At the same time tests of numerous types of welds have been conducted.

The two electrodes of the torch are tungsten rods, held at an acute angle with each other by lava insulators. When not in use, the electrodes are in contact with each other; they can be separated by pressure on a lever mounted on the handle. A set screw is provided for making slow adjustments of the electrodes. The hydrogen is supplied by a tube through the handle. Sufficient gas is used so that the electrode tips are surrounded not only by enough to form the blast of atomic hydrogen but by an additional quantity to surround the work with hydrogen.

Either alternating or direct current can be used. The first mentioned has been found more convenient, and electrodes of smaller diameter can be used. The gas pressure required to operate the torch is small; in the laboratory, with short lengths of tubing, a pressure of less than 1 lb. per square inch was sufficient with metals up to ½ in. in thickness. For ordinary welding, the rate of gas consumption is said to vary between 20 and 30 cu.ft. per hour.

Since the maximum rate of heating is desired in welding, the torch is held close to the metal. Best results have also been obtained when the torch is inclined so that the blast of hydrogen from the torch passes over the pool of molten metal in a direction opposite to that in which the torch is moved along the line of the weld. In this way the metal at a given point heats and melts rapidly, but cools slowly, permitting dissolved gases to escape before the metal freezes.

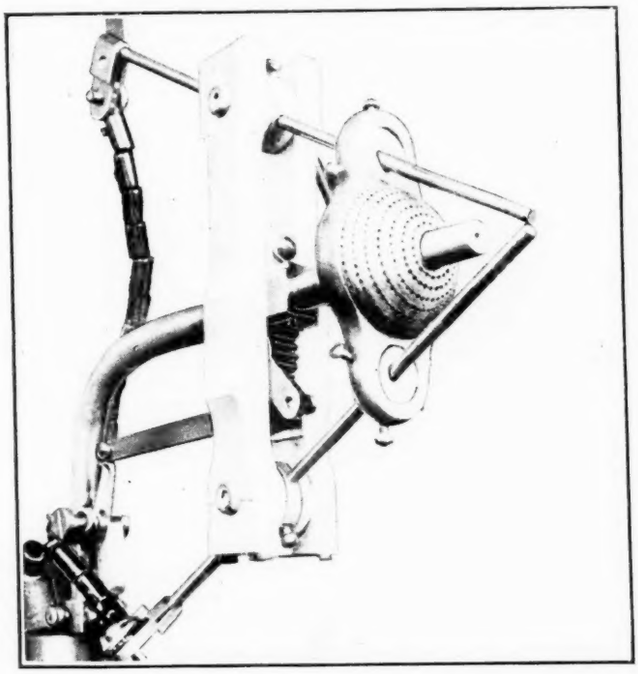


Fig. 1—One type of torch employed for atomic-hydrogen arc welding at the Schenectady laboratory

Experiments have been conducted with several gas mixtures and various electrode materials. The best results have usually been obtained with tungsten electrodes and hydrogen alone.

It is claimed that materials of many kinds have been successfully welded by this method and that low-carbon steels up to ½ in. in thickness have been welded without additional material after butting together tightly. Considerable work has also been done in connection with full automatic welding, using a butt joint, and with no metal being added to the seam. A number of welds have been made on seamless tubing having a wall thickness of ¼ in. and an outside diameter of 4 in., and with boiler-plate iron 1 in. thick. Welds on deoxidized copper such as silicon-copper have been made up to ¾ in. thick metal. These are said to give unusually good sections.

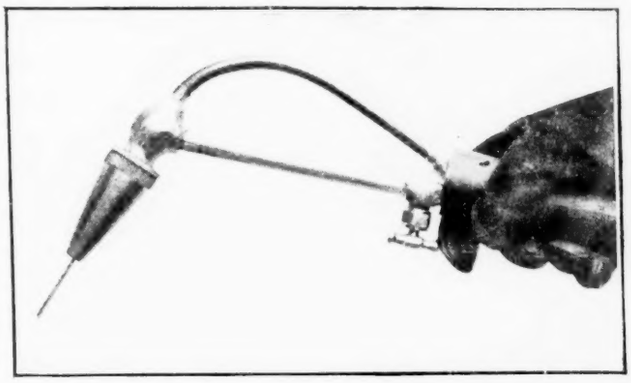


Fig. 2—New model of torch as developed at Lynn for arc welding in an atmosphere of hydrogen

Here much of the welding heat comes directly from the arc between the single electrode and the work, the hydrogen bath serving mainly to exclude air and thus avoid contamination of the metal. However, some atomic hydrogen is produced by this torch.

Many different forms of torches have been constructed and tested. The torch shown in Fig. 1 has been extensively used. In addition to the central orifice providing the jet impinging directly upon the arc and thus producing the atomic hydrogen, streams of smaller velocity escape from the small openings in the surrounding hemisphere and bathe the electrodes and the work with hydrogen.

This bathing gas excludes the oxygen and nitrogen of the air, which might produce oxides and nitrides, thus impairing the well. It also assists the atomic hydrogen in reducing to pure iron any particles of oxide that may be present in the fused metal.

At the present stage of development it is customary to use single-phase alternating current with an open circuit voltage of approximately 400. In normal operation, the drop across the arc is about 80 volts. To avoid danger to the operator the entire arc circuit is preferably insulated from ground.

Another Hydrogen-Arc Process Developed by Thomson Laboratory

Long before the properties of atomic oxygen were known or even dreamed of, it had been suggested that a bath of hydrogen or other reducing gas would be advantageous during the welding process. Peter Alexander of the Thomson Research Laboratory at Lynn is one of those who has carried out research on this line principally to improve the ductility of the weld and with the incidental object of speeding up the welding process.

Announcement of a practical method of welding based on this principle was made simultaneously with that of the process developed in the Schenectady laboratory

The method is based on the action of ordinary molecular hydrogen. This gas at high temperatures, even in the molecular state, is a very active reducing agent. When it surrounds the crater of the arc, it acts in the same way as it does in the hydrogen-brazing process. Yet certain peculiarities of the process (for example, the extremely high-voltage drop at cathode and anode of the arc burning in hydrogen) are due to the dissociation into atoms of the small amounts of molecular hydrogen in actual contact with the craters. Hence, according to Mr. Alexander, the apparent resistance of the arc, and consequently the amount of energy liberated, is about double that when the arc is burning in air.

The result is said to be uniformly ductile welds and much faster operation. The speed results both from the greater energy of the arc in the hydrogen atmosphere and from the fact that beveling the edges of the material is unnecessary. Using 180 amp. and an arc voltage of 60, ½-in. boiler plates, butted together without beveling, have been welded at a speed of 60 ft. per hour.

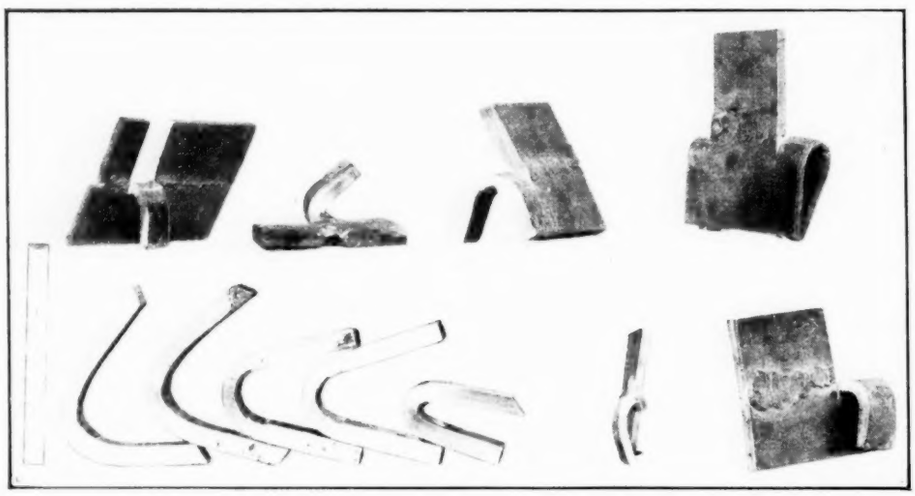


Fig. 3—Welds made in hydrogen atmosphere (Lynn method) tested for ductility

Ductility is a factor of prime importance in the welds of structures that are subjected to vibration, accidental bending stress or overload. The investigators also call attention to the fact that ductility equalizes internal cooling stresses when present in the weld. It is stated that if any part of the ductile weld is stressed beyond its elastic limit, it will not crack, but will yield until the stresses are more or less equalized all along the joint, which is so proportioned as to stand with safety the imposed load. It is also reported that the metal deposited in the hydrogen atmosphere has a higher elastic limit—that, whereas the elastic limit of pure-iron electrodes before deposition averages 29,000 lb. per square inch, that of the same electrode deposited by the arc in hydrogen averages 42,000 lb.

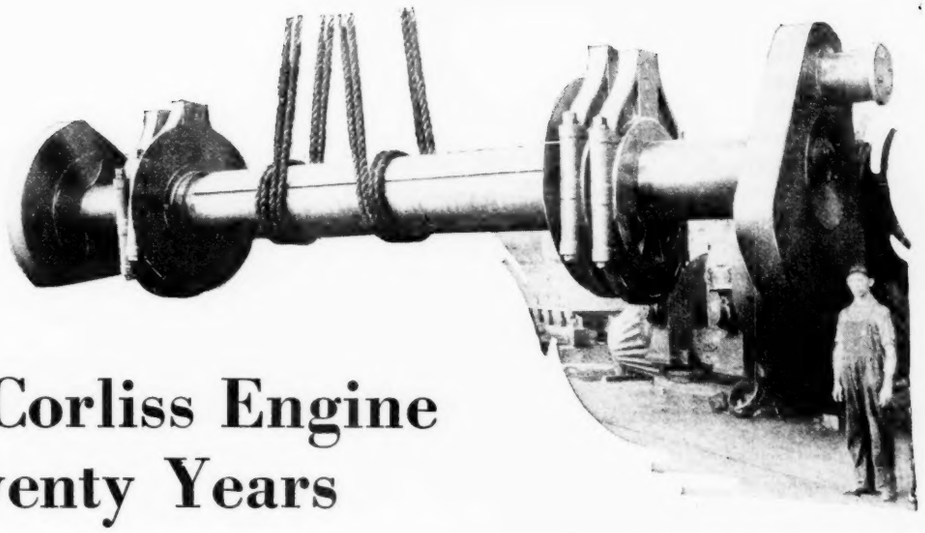
In this welding process the arc is maintained inside of a hydrogen stream, which burns along its outer surface of contact with air. The electrode is entirely surrounded by hydrogen, which eliminates the possibility of the metal in the crater coming in contact with air. Direct current is used. The equipment as developed in the laboratory includes the direct-current generator, gas hose and spool of welding wire mounted as a unit on one base. The welding wire, the hydrogen gas and the electric current are sent through a flexible hose to the torch nozzle. One model of semi-automatic torch is shown in Fig. 2.

After the work with the hydrogen atmosphere was found to be successful, experiments with mixtures of hydrogen and carbon monoxide were conducted in accordance with Prof. Elihu Thomson's suggestion and under his personal guidance. Water gas, containing about equal volumes of hydrogen and carbon monoxide, was next tried. It was found that welds produced in such an atmosphere were ductile and easier to produce. Work with various mixtures of carbon monoxide and hydrogen, produced either synthetically or by decomposition of various organic compounds, are said to demonstrate that ductile welds can be produced in the atmosphere of any mixture of the two gases. Methanol or synthetic wood alcohol was found to serve well as a source of gas. The use of methanol would facilitate transportation with portable outfits. A series of experiments with nitrogen-hydrogen mixtures showed that mixtures of these gases also give ductile welds. The use of liquid anhydrous ammonia, which contains one volume of nitrogen and three of hydrogen, makes it possible to store large quantities of gas in small volume as a liquid. Still other gases and methods are being investigated in the Lynn laboratory, and academic studies are being made of the theoretical aspect of welding in different gases. In its present state the process is being extended to the welding of alloy steels, non-ferrous materials and their alloys. The careful selection of the appropriate gaseous mixture determined by the nature of the materials to be welded is an essential factor for successful work.

In brief, this process is a combination of an electric arc that supplies the energy and an appropriate chemical reagent, which, being in a gaseous state and at high temperature, acts almost instantaneously.

The chemical composition of the fuel ash has a large influence on the life and behavior of a refractory wall, and, strictly speaking, the refractory should be selected to suit the ash. In actual practice this cannot be done, because the nature of the fuel burned is not constant. It should be remembered, however, that a firebrick giving good service under one set of circumstances may fail badly under others, and that an important element of difference is often the nature of the ash. Some types of ash build on the wall up a slag layer that really protects the brick, whereas ash of a different composition will flow down the wall surface and flux the brick with it, much as water would dissolve sugar or salt.

A spray pond should have 2½ sq.ft. of area per gallon of water to be cooled per minute. This includes the marginal straps necessary for windage, etc.



The main shaft is thirty-five feet. Its massive proportions can be judged by comparison with the man in the foreground.

Largest Corliss Engine in Twenty Years

A twin tandem engine capable of developing a maximum of fifteen thousand horsepower at two hundred pounds steam pressure is being installed for rope drive at one of the large steel mills.

IN SPITE of a prevalent opinion that the days of the Corliss are past, an appreciable number are built each year, mostly in large sizes. Among these there has been placed in operation recently in the plant of an Eastern steel mill a Corliss engine that is notable as being the largest installed during the past twenty years, and in fact one of the largest stationary engines ever built.

This engine is an Allis-Chalmers twin tandem-compound having two high-pressure cylinders, each 44-in. diameter, and two low-pressure cylinders of 84-in. diameter, all having a stroke of 66 in.

At present the engine is operating condensing on an initial steam pressure of one hundred forty-five pounds gage, but later it will operate with steam at two hundred pounds pressure.

At its speed of seventy-two revolutions per minute and a steam pressure of one hundred and forty-five pounds, the normal rating of the engine at the point of best economy is eight thousand five hundred indicated horsepower, corresponding to a mean effective pressure, referred to the low-pressure cylinder, of thirty-six pounds per square inch. It is capable of developing a maximum of twelve thousand. With two hundred pound initial steam pressure, the normal rating will be ten thousand indicated horsepower and the maximum fifteen thousand, corresponding to a mean effective pressure of fifty-six pounds per square inch.

The engine is driving rod mill rolls. About two-thirds of the power is taken off at the flywheel, which is grooved for seventy-six two-inch ropes and one-third is transmitted directly from a return crank.

Fig. 1 is a view of the engine erected on the shop

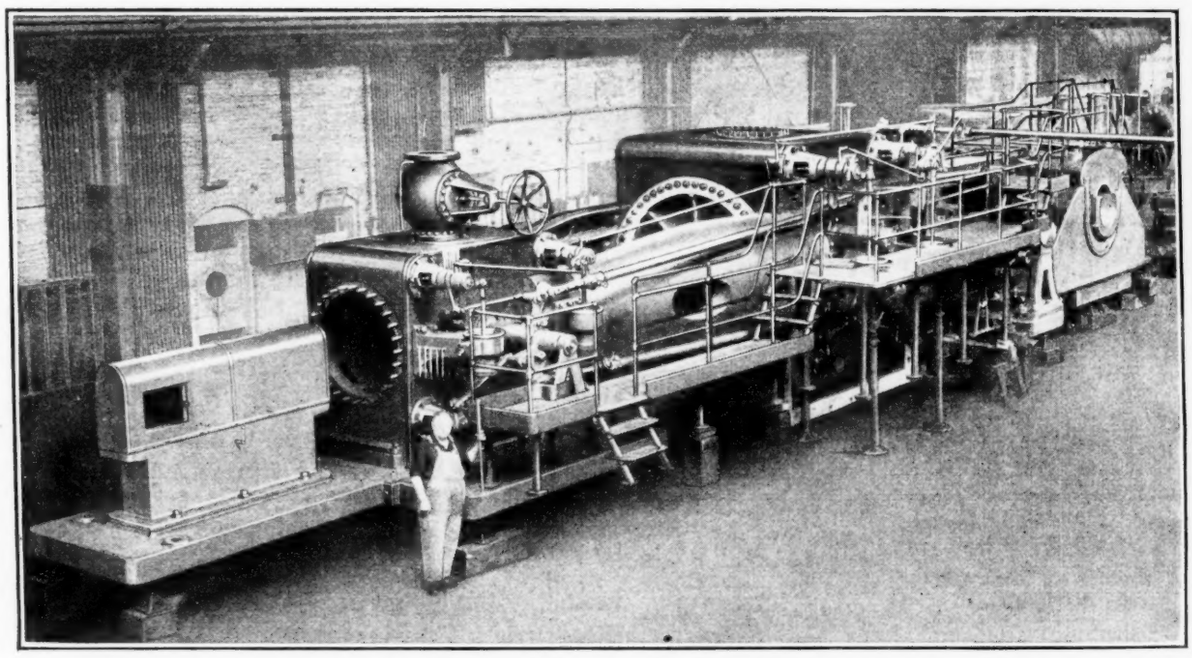


Fig. 1—One side of engine on shop erecting floor

floor just before shipping, and Fig. 3 is a plan and elevation from which may be gained an idea of the general arrangement and the type of valve gear employed. The enormous proportions of the main shaft may be judged by comparison with the man shown in the headpiece. The shaft is thirty-five feet long. In the journals it is twenty-eight inches diameter and in the wheel its diameter is thirty-four inches. The diameter of the rope wheel is twenty-two feet, its face eighteen feet and the weight 260,000 pounds. Fig. 2 shows the huge eccentric and strap employed in this big engine. Similar equipment for a five hundred-horsepower engine, which is mounted in front, makes an interesting comparison. The pistons are of the floating type, the weight being carried by tail rods. High-pressure rods are twelve-inch diameter and the low-pressure rods sixteen-inch. The total weight of the engine is approximately 1,600,000 pounds.

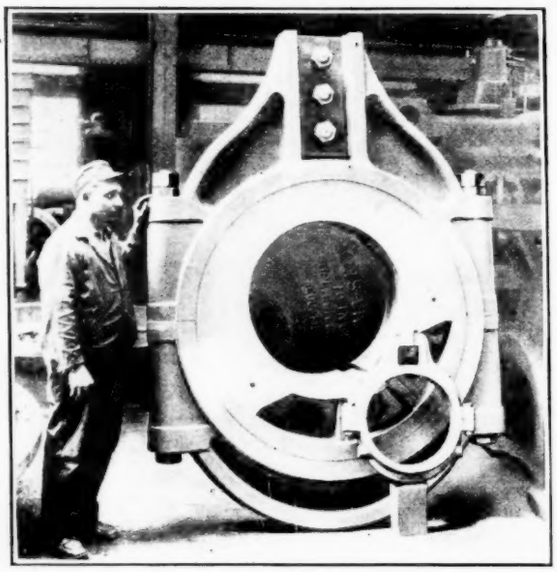


Fig. 2 (at right)—Relative sizes of eccentric for the big engine and that belonging to a five hundred-horsepower Corliss, as seen in the lower right-hand corner of the picture

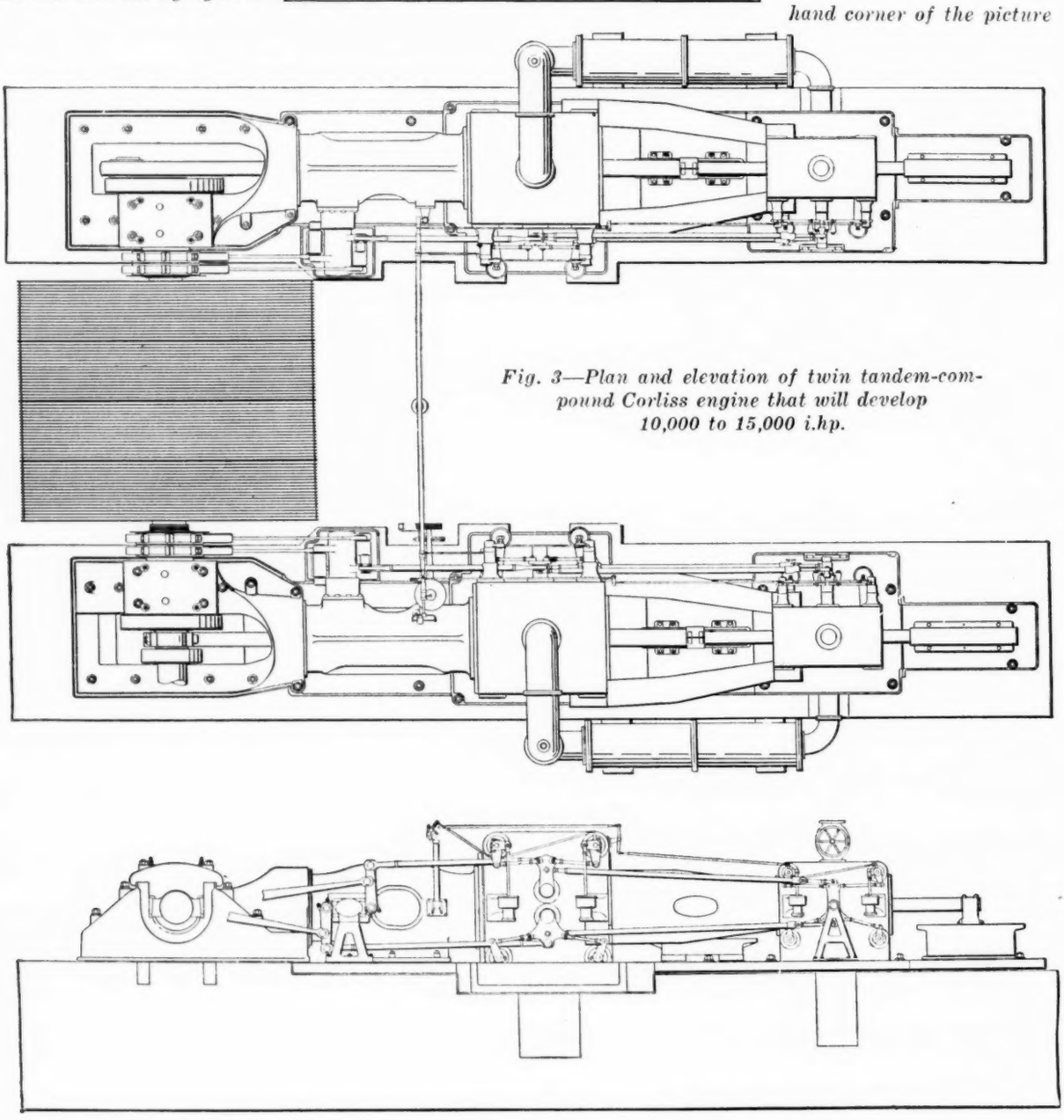


Fig. 3—Plan and elevation of twin tandem-compound Corliss engine that will develop 10,000 to 15,000 i.hp.

Estimating Fabricated Pipe Costs—II

By IRA A. BUTCHER

In a previous article (March 16 issue) information was given on the cost of oxyacetylene welded pipe work and how to compare it with the cost of a job put up with fittings. The present article deals with the cost of cutting and threading operations, making on flanges, lap joints, pipe bending and laying out so as to keep the cost down.

LAP JOINT fabrication consists of two operations, one of which is the turning of the lap and the other is the facing, back facing and edge machining of the lap after it is turned, the combined prices of the operations for making one lap on extra heavy or standard steel pipe being as follows:

2 in. to 3 in. diameter pipe, price per inch diameter.....55c.
3½ in. to 5 in. diameter pipe, price per inch diameter....50c.
6 in. diameter pipe, price per inch diameter.....45c.
8 in. diameter pipe, price per inch diameter.....40c.
10 in. to 24 in. diameter pipe, price per inch diameter...35c.

If the laps are on pipe bends, 20 to 40 per cent should be added to the above prices, the higher percentage being added to the smaller pipes.

These prices will usually cover either the square lap or the round lap and are for reasonable quantities. (See Fig. 4 for round and square laps.) For single pieces of a size an extra may be charged, although such a charge is usually not made except on rush orders.

For extra long lengths of pipe such as double random* the above prices may be increased 50 per cent, although again they may not be, depending upon the condition of business and the shop that is figuring the job.

Cutting, Threading and Making on Flanges

For making one cut and cutting two threads on pipe 6 in. in diameter and under the price per inch diameter of pipe is 15c.; for pipe 7 to 10 in. inclusive, figure per inch diameter 20c.; for pipe 12 in. diameter, figure per inch diameter 25c.; for sizes larger than 12 in. get special prices, which may range anywhere from 35c. to 70c. per inch diameter per end threaded, 50c. being a fair average.

Unless otherwise specified it is the standard practice to cut the threads so they will make up tight with the end of the pipe two to four threads back from the face of the flange. For making on flanges figure 5c. per inch diameter of the pipe. For peening pipe into flanges figure 5c. per inch diameter of the pipe. For making up pipe so the end extends through the face of the flange and is faced off flush, taking a light cut over the face of the flange, figure 15c. per inch diameter of the pipe.

In estimating the cost of forged steel lap joint flanges the price may be taken as 11c. to 12c. per pound for flanges 12 in. in diameter and smaller, adding 1c. to 2c. per pound for larger sizes up to 24 in. diameter, the price varying with the quantity and size, the larger sizes taking a somewhat higher price than the smaller sizes.

These prices are generally safe for estimating purposes, but it would be well to get prices for jobs requiring large quantities of flanges, as the steel flange business is operated on a very narrow margin of profit, so flange makers must follow the steel market. The above prices include drilling, facing and chamfering.

Cast-iron flanges with cored holes may be figured at 6c. per pound, this price including the facing and drilling. If drilled bolt holes are desired, add ½c. per pound to the above price.

Filler Pieces

In laying out a pipe line, short filler pieces should be avoided, as the minimum length which can have machine-turned laps must be long enough to accommodate the die block of the flanging (lap) machine in addition to the hub depth of two flanges and the thickness of two laps, otherwise one lap will be machine turned and the other will be hand turned at an extra charge. It is to be noted that only the round corner lap can be hand turned.

The die block on a lapping machine is usually 6 to 12 in. long, and this distance must be allowed for in determining the shortest lengths which are to be used.

Bending Pipe

Pipe bends are estimated on the basis of one bend of 90 deg. or less forming the unit of calculation. Thus for a U-bend the price would be double the price of a 90-deg. bend whereas an expansion bend as shown in Fig. 1 would be computed as four bends, and an expansion bend as shown in Fig. 2 would be computed as six 90-deg. bends. An expansion circle would be computed as five bends because of its helical shape, unless it was offset so as to make the inlet and outlet in line, in which case it would be computed as seven bends.

An offset bend as shown in Fig. 3 would be computed as two bends, whereas if the bend were in two planes as in Fig. 4, the price would double for the bend in the

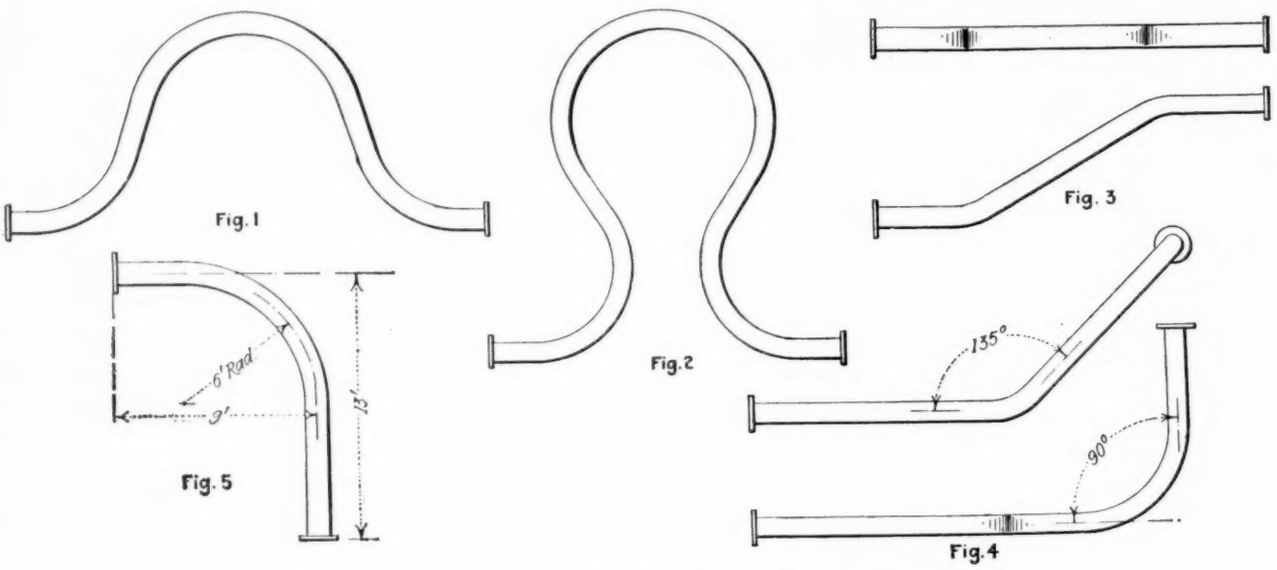
*Approximately 38 to 40 ft.

second plane, the complete bend being known as a 90 deg. and angle bend and the price computed as a total of three bends of 90 deg. each.

Bends 3 in. in diameter and under may be figured per inch diameter at 75c. to 80c. Bends 4 to 6 in. diameter may be figured at 90c. to $1, bends 8 to 12 in. diameter at $1 to $1.10, bends 14 to 16 in. diameter at $1.35 to $1.50, bends 18 to 24 in. diameter at $1.65 to $2. These prices are for making one bend of 90 deg. or less and are to be multiplied by the nominal diameter of the pipe for obtaining the total fabricating price. For bends made of double random pipe 30 ft. long or longer, add 50 per cent to the above prices.

The larger the diameter of the pipe the longer the waste and in fabricating labor, as may be seen by studying Figs. 6 and 7, the former showing a common layout and the latter a better one. Both are made for the use of the fabricator.

By insisting that the dimension shown in Fig. 6 be followed it will be necessary to calculate one cut for each straight piece of pipe and two cuts for each bend, as stock pipe comes only in random lengths which do not correspond with specified lengths except occasionally. If Fig. 7 is followed, the fabricator would start, say, at the right-hand end and make a bend of a random length of pipe, with one leg 11 ft. center to end, allowing the other leg to terminate where it would. He would then probably make the other bend



Figs. 1 to 5—Illustrating some common pipe bends

tangents required to make the joint connections and for holding the pipe while bending it.

A cut should be allowed for on each end of each bend which must be made to fixed dimensions.

Computing Pipe Required to Make Bends

In figuring the amount of pipe required to make a given bend, compute all circular lengths as if they were tangents and multiply by 0.8. This is a little more than is actually required, but it is only slightly so and is near enough for estimating purposes. Thus in Fig. 5, a 90-deg. bend (also known as a square bend) one leg of which is 9 ft. center to end and the other 13 ft. would require 9 ft. — 6 ft. + 13 ft. — 6 ft. + 0.8 (6 ft. + 6 ft.) = 19 ft. 6 in. of pipe, although a shorter way to calculate to the required length would be to deduct 0.2 ft. for each foot of arc, measured as tangents; thus, 9 ft. + 13 ft. — 0.2 (6 ft. + 6 ft.) = 19 ft. 6 in.

Laying Out Piping

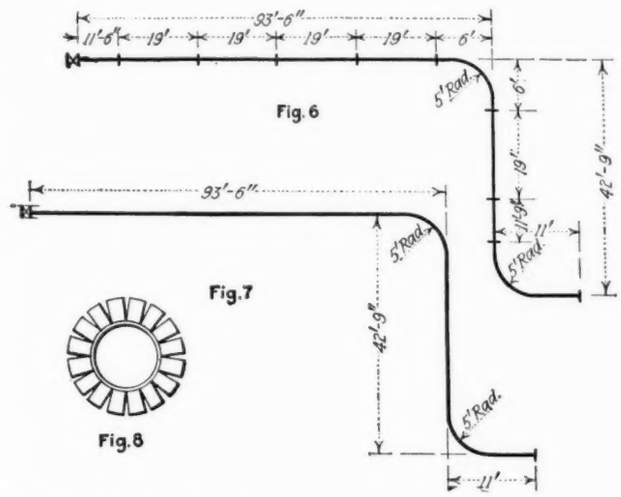
In laying out pipe lines it is a profitable plan to make a practice of giving only over-all dimensions and dimensions of intersecting points and make no attempt to locate joints except where absolutely necessary, when the plan is for the use of the fabricator in estimating or getting out the job. By this method a saving will be made in the cost of making the drawings, in pipe with a short leg for the 93 ft. 6 in. line and the long leg for the 42 ft. 9 in. line. If he has a reasonable stock of pipe on hand and has done a little figuring, he will be able to make the connecting piece between the two bends of one piece of pipe, which he will have to cut to the exact required length. On the 93 ft. 6 in. run he will have to fabricate four straight lengths of pipe, ascertain their total lengths plus the length of the leg of the bend and cut a filler piece to complete the run. By following this procedure there would be only three cuts to make in getting out the entire lot of pipe, whereas if the other method were followed, there would be eleven cuts to make with 5 ft. or more of scrap pipe, three short pieces left over and one extra joint to make, which would amount to a noticeable sum if the pipe were 10 or 12 in. in diameter and fitted with forged-steel flanges.

If there are certain intermediate locations where joints must not occur, make a note of them on the plan, and the fabricator, by careful selection from his stock, may be able to avoid cutting and waste, but the chances of his doing so are greatly reduced by indicating exact locations for the necessary joints on your plans.

In specifying drip outlets it will be cheaper to have extra heavy couplings welded to the pipe than to use tapped pads, the cost of cutting the hole in the pipe and welding the coupling in place being approximately

25 per cent more than the cost of welding a plain nozzle of the same nominal diameter. This extra cost for the welding of the coupling is due to the fact that the coupling is larger in diameter than the pipe of corresponding size and therefore requires more welding.

Welded pads are sometimes made of ordinary forging steel in which it may be difficult to cut a good clean thread or they may be made of a special grade of free-cutting stock somewhat higher in sulphur than the forging steel. They may be drilled and tapped before they are welded to the pipe (which is the usual method) or they may be drilled and tapped after they are welded to the pipe. The latter method makes the cleaner job, as it leaves the threads true and clean and the hole is less likely to be out of round than if the tapping is



Figs. 6 to 8—Showing how savings may be made in cutting pipe

done before the welding; however, it costs more, because it is easier and cheaper to handle a small piece of material like a pad for drilling and tapping operations than it is to handle a large piece of pipe for the same operations.

The cost of a pad is largely governed by its outside diameter, the welding being figured at the same price per inch diameter as the welding of a nozzle except that the outside diameter of the pad is used in determining its price, whereas the nominal diameter of the nozzle is used for computing its price. In addition to the welding the cost of the material for the pad and the cost of the drilling and tapping operations must be included, these usually ranging from 75c. to $1.50 for pads up to 3 in. diameter.

Cost of Pipe

In estimating the cost of pipe, use a price that will allow the fabricator 10 to 15 per cent margin as a handling charge for unloading the pipe from the cars, putting it through the shop and reloading onto cars or truck. If you are figuring on a carload of pipe and have time to wait for mill shipments, use mill prices and add the above percentages together with the freight. If you desire immediate deliveries, use warehouse prices and add the above percentages. Freight should be figured from the mill to the fabricating plant and from the fabricating plant to the job, but in some cases the fabricators will equalize the freight with the competitor nearest the job.

Fabricating prices for wrought-iron pipe are the same for all operations except lapping as for steel pipe, although usually all scrap is charged against the job regardless of how long any of the pieces may be which are left over.

If wrought-iron pipe is lapped, it "sunflowers" by splitting in many places; hence the lapped end will appear somewhat as shown in Fig. 8 before welding. After the lap has been turned, the splits are made solid by welding with the oxyacetylene torch; hence the turned end of the pipe is a mixture of wrought iron and cast steel. The welding of the split ends increases the cost of the lapping operation; therefore it must be figured at about three and one-half times the cost of lapping steel pipe.

Some engineers use the ring type welding flange on wrought-iron pipe, the cost of welding and facing operations being $2.25 to $2.50 per inch diameter of pipe.

Sentiment in the South apparently is becoming less favorable to leasing Muscle Shoals to any large manufacturer. This is because of the fear that it would entail a labor problem difficult to meet in some sections. Although property immediately about Muscle Shoals would probably be enhanced in value through the erection of any large factory at the Shoals, it is stated that the effect on the South as a whole would not be beneficial. There is but a small amount of labor available in the vicinity of the plant, and a section included in a 200-mile circle about the dam would be drawn upon for the needed thousands of workmen. The resulting scarcity of white labor would immediately send wages soaring, thereby working to the detriment of all the Southern textile plants, cotton-oil mills, steel works, etc. As the property of many of the large interests is dependent directly upon cheap labor, it is not surprising that the arrival of a large manufacturer, such as Henry Ford, would not be awaited with open arms. This is especially true if the Shoals lessee happens to be one who has established a custom of paying a high basic wage. Indirectly, the farming element would feel the pinch, for the dearth of white labor would force mill owners to take in negro hands, which would mean a scarcity of negro tenant farmers and "croppers."

When one hears of high winds disrupting electrical service, he usually thinks of transmission lines and practically never of circulating water. Yet the wind can, under certain circumstances, deprive a plant of its circulating water. The case in mind occurred during the blizzard which swept the northeast portion of the United States about a month ago. The wind, which was off shore, forced the level of the tidewater down to such a point that at low tide it fell below the circulating intake of an important stand-by station on the Atlantic Coast. It was nearly two hours before service was restored.

It might be well to check up on the condition of the non-return valve the next time a boiler is cut out. This is readily done by shutting off the air and fuel and noting the time required for the pressure on the boiler to drop below that on the main header. If the pressure does not lower after seven hours, either the valve has not closed or it leaks, and requires attention.

Governor Smith's Water-Power Policies

In an Interview with F. R. Low, New York's Chief Executive Explains How His Proposed Water-Power Policy Would Function

REALIZING that the issues brought to the front by the current discussion of Governor Smith's water-power policies are of much more than local and present interest, the editor of *Power* sought and was accorded an interview with the Governor with a view to presenting authoritatively the plan proposed, the possibilities which it offers and the social-economical policies involved. With the growing importance of power as a factor in our manner of living, the seriousness of the control of its sources becomes impressive. The water powers are the only natural resource remaining in the possession of the people. The problem is to get them to working without letting go of their possession and control. The usual process is for a group of individuals to get from the state a concession of its rights in and title to a water power. They then borrow or subscribe enough capital to develop the project, hire engineers to design and build it and organize a corps of executives and operatives to run it. In addition to their profit they charge enough for power to pay the interest on and return to them the money that they have invested, and come out in complete possession of a property greatly enhanced in value. Certain provisions are included under which the government at the end of fifty years may "recapture" the project or readjust the terms under which it is ceded, and attempts are made to protect the purchasers of the power from extortionate charges through commissions, but much may happen in fifty years and many factors enter into rate control. It is a good deal better for the people to keep their resources, but they must not keep them stagnant.

Governor Alfred E. Smith © Underwood & Underwood

Once the great rights, franchises and properties of the state in water power and the rights-of-way are granted to a monopoly, they can be repurchased and condemned only at prohibitive prices. This has been the history of gifts of public resources and rights-of-way for the past century.

The Governor does not see why the state itself cannot do for the people just what this group of individuals does in its own interest. All the rest of the personnel involved, the engineers and executives and operators, have to be hired anyhow—and the state can hire as good ones as a company can. He proposes, then, that the people, instead of turning their birthright over to a group whose natural incentive is to get as much profit out of it as possible, turn their water powers over to a body which he proposes to call the New York State Power Authority, a corporation constituted along the same lines as the New York Port Authority. This body would develop the powers in the same way that a group of individuals would, performing their functions in fact, but the waterways and improvements and rights-of-way and unearned increment and unseen possibilities would remain in their possession and control, in trust for the people of the State of New York.

The major cost of producing power hydraulically is the interest charge upon the greater investment required per unit of output. The Governor believes that the bonds that would be offered by the Power Authority, exempt from state and federal taxation, having behind them the perpetual franchise to these valuable water privileges, including the right of eminent domain, backed by contracts for the disposal of the products of their operation, could be floated at a considerably lower rate of interest than could the bonds of a private company.

In this belief he is sustained by Owen D. Young, who, under date of Feb. 9, wrote to him as follows:

> The cost of energy developed from falling water is determined very largely by the cost of the capital employed in the development. A public corporation such as you propose, whose securities would be exempt from taxation under the federal law and under the state law, should produce, if properly set up, the required money substantially cheaper than a private corporation could obtain it.
>
> It is not intended that these securities shall be in any way backed up by or involve the credit of the state

any more than are the securities offered by the New York Port Authority.

The Greenville tunnel is going to cost $32,000,000. Not one dollar of public money will go into that tunnel. Bonds will be issued for its construction and the bonds will be backed up by a contract with the railroads entering New York from New Jersey to send a given tonnage through it per year. The Port Authority goes into the money market with that contract as its security just as a man who has been awarded a profitable contract goes to a bank and borrows money to carry it out.

I remarked that if a hydraulic development cost even as much as $300 per kilowatt the ability to get money at 4 instead of 6 per cent would result in a saving of only about one-fifth of a cent per kilowatt-hour with a use factor of 35 and only about one-tenth of a cent with a use factor of 70. This slight difference in cost would not have any perceptible effect upon rates of 8 or 10 cents per kilowatt-hour. Would the average citizen who does not see beyond his own electric light bill be disappointed in the outcome?

One-fifth or even one-tenth of a cent per kilowatt-hour is a very considerable percentage of the price at which hydraulic power is sold to the industries. In some cases this is as low as 3 mills per kilowatt-hour. The state is selling power from its own publicly operated plants at a profit. And the average citizen pays a whole lot more for power in his purchases of food and clothes and transportation and other commodities and service than he does in his electric light bill.

Power, in one form or another, enters into the production, transportation and distribution of practically every commodity and service that he pays for and uses. The control of the natural sources of power would give to its possessor a mastery over his fellows and opportunity for extortion possessed by no autocrat of any previous empire, visible or invisible, feudal or industrial.

Looking to the Future

The essential thing is to keep the ownership and control of these resources in the hands of the people and still get them to working. Our use of and dependence upon power is increasing enormously. The electrical utilities are increasing their output some 10 per cent per year. If this rate of increase continues, they will have doubled their production in a little more than seven years. Coal is getting scarcer and more expensive, the water powers are being made more available and valuable as the possibilities of transmission and interconnection are developed. We must not sacrifice our ability to control exploitation of these conditions by relinquishing the possibility of public competition and public knowledge of true costs through actual public experience.

The formation of a corporation that can act with all the freedom from bureaucracy and political interference that a private corporation can, that will operate these properties not for the profit of its stockholders but for the benefit of the public and hold the people's title in them subject to the best use under conditions as they may develop seems to offer a simple and practical solution of the problem and to meet the chief arguments that have been urged against public development and operation.

General G. E. Tripp says: "The contracts of any government-owned agency can be nullified at will by political action and there is no higher power to enforce their continuance. Therefore, if a private power company contracts to buy power from a state-operated generating plant, it can never be sure that the price agreed on will not be increased, directly or indirectly, or that, indeed, the contract will not be in effect abrogated whenever it suits political exigency to do so."

The proposed Power Authority would be as amenable to the law as to its contracts and all things else as though its stock were owned by individuals. It can do nothing under the urge of political expediency that it would not be legal and right for any other corporation to do. The fact that all the interest in it is owned by the state does not relieve it of subjection to the law.

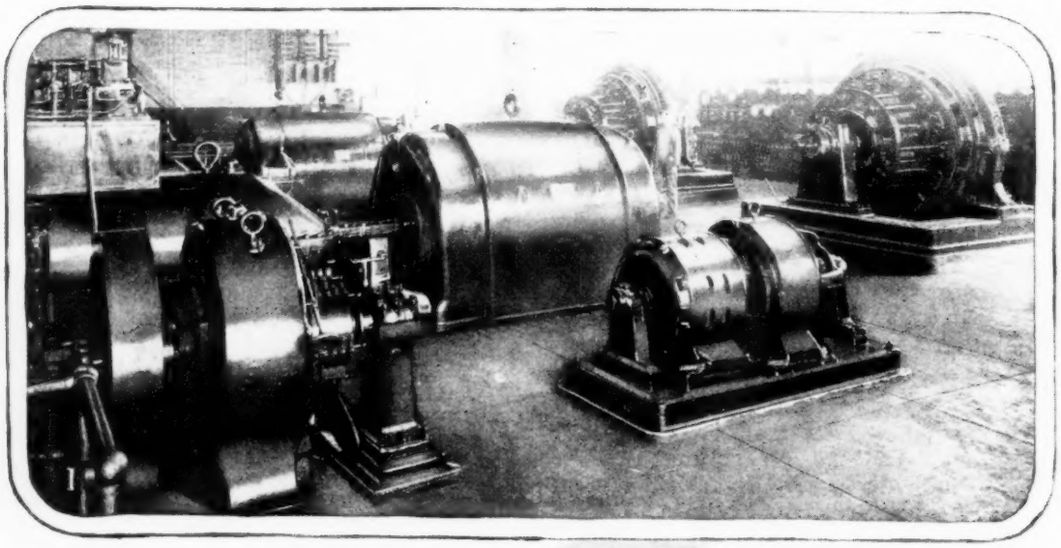
Precedent Set by Former Governors

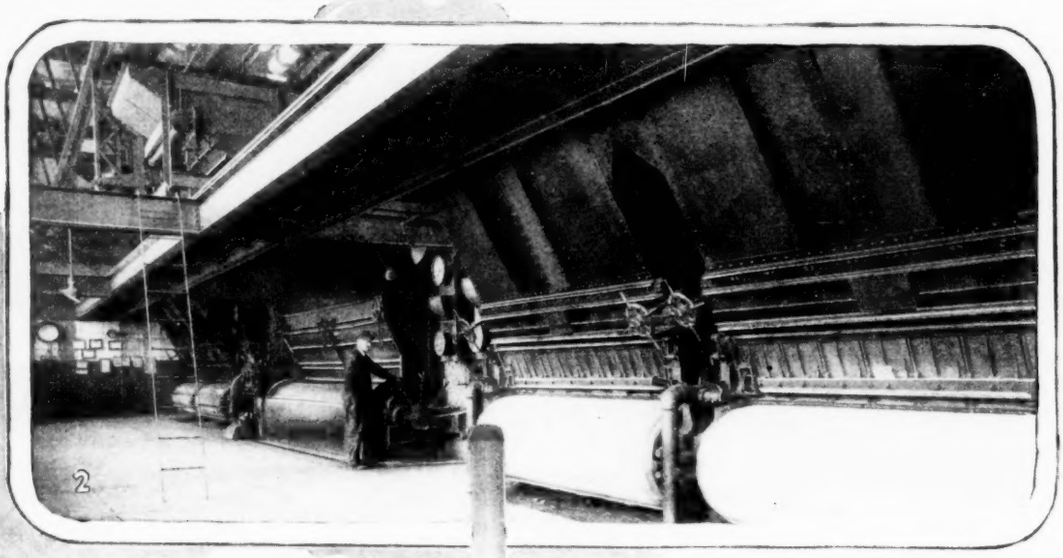
And there is nothing socialistic or communistic or paternal or even new in it. Nathan L. Miller when Governor established plants at Crescent Dam and Vischer's Ferry on the Barge Canal and the state is operating them and selling at a profit the current they produce; Charles E. Hughes when Governor advocated water-power development under state ownership and control; Owen D. Young sees no objection, but on the contrary some advantages, to the development of the great water powers on the St. Lawrence and in the gorge of Niagara by a public corporation rather than by a private corporation and to the ownership of all lands, water rights, flowage, dams, power houses and structures by such a public corporation. There is a growing willingness upon the part of the most far-sighted of the utility corporation leaders to consider the public development and operation of such publicly owned resources provided their output is sold to them in block and they are not disturbed in their function as retailers and distributors.

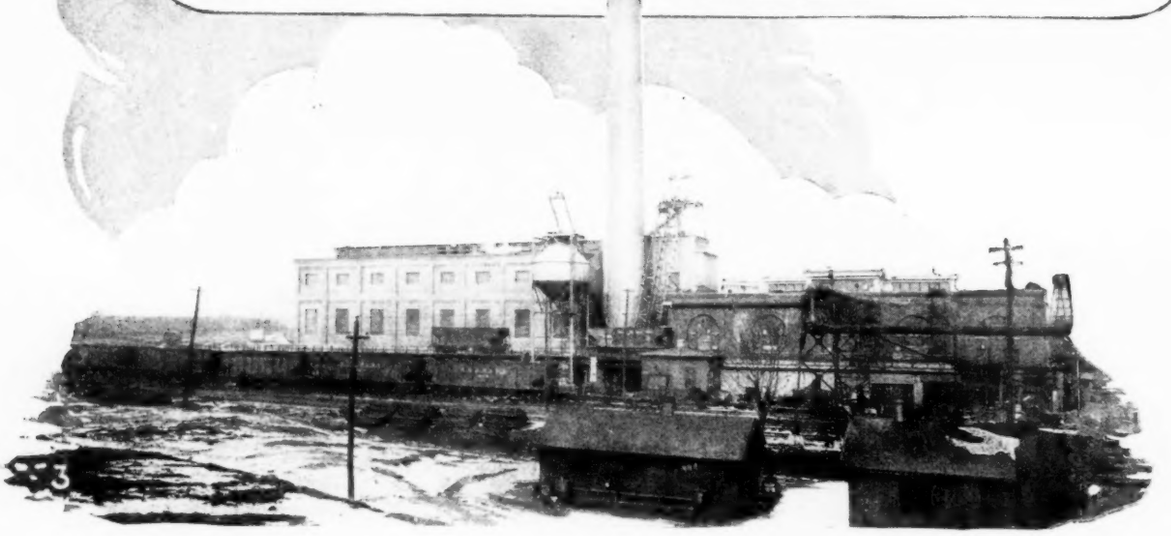
Whether or not the New York State Power Authority shall sell only to the utilities or, on opportunity, directly to large consumers; whether the properties shall or shall not be subject to local taxation and similar questions are details to be treated by and for the public corporation just as they would be in the case of a private corporation. The Power Authority would be simply in the position of a corporation the whole of the stock of which was owned by the state. It would not be possible to delegate to such a corporation the complete development and utilization of a waterway with respect to flood control, municipal water supply, etc. The federal government has jurisdiction in so far as navigation is concerned, other state departments in the other matters. The Power Authority would be simply a corporation charged with the duty of developing and operating to the best advantage such potential water powers as still remain within the control of the state. In the matter of interconnection with other systems and the exchange of power it would be the only agency that could intelligently and effectively act for the state. In the matter of the conflict of authority between the state and federal governments over the development of border or other streams the Power Authority would be equipped as no department of the state government could be to represent the interest of the people of New York.

I do not present the above as a literal transcript of what the Governor said to me, and do not know that he would father all the expressions that I have used. What I have written is the picture of the Governor's vision that I brought away with me after a half-hour's conversation with him, set down with a profound conviction of the sincerity of his belief in the soundness of his proposal.

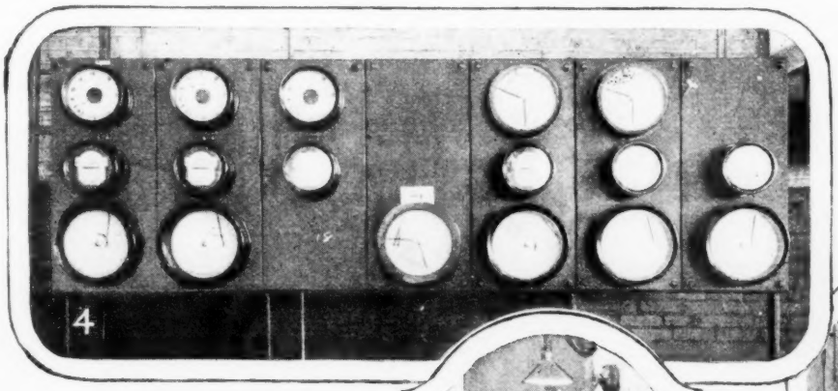
Modern Boiler Plant Handles U

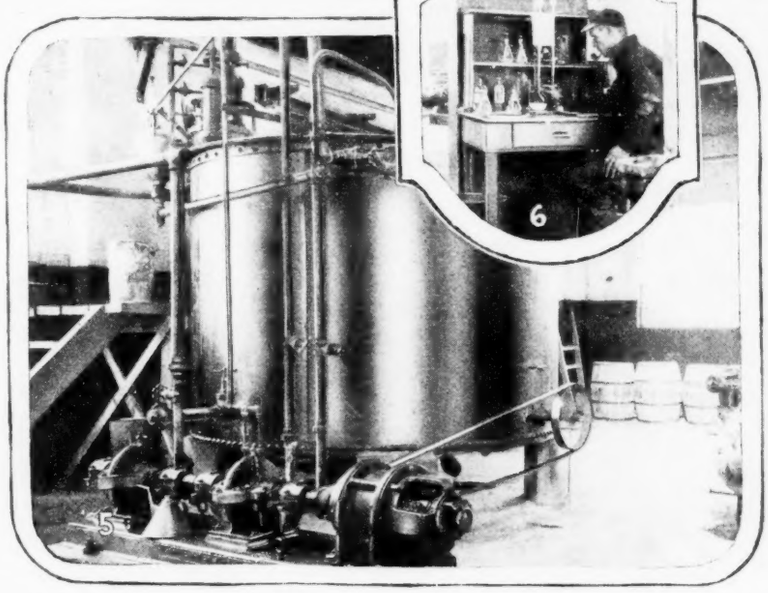


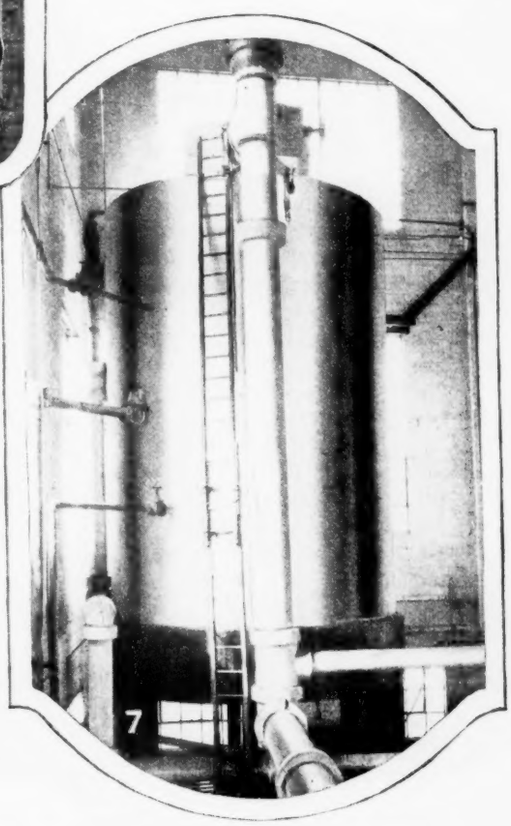




Unusual Load at Reading Pier







Plant Operates Huge Terminal

ON THE OUTSKIRTS of Philadelphia, at Port Richmond, on the Delaware River, is the Pier 14 Terminal of the Reading Company, now one of the largest coal- and ore-handling terminals in the world. The power plant, built in 1910, has grown with the terminal, which is equipped to load and unload ocean-going ships. In addition to a huge unloading crane is a car-dumper with two 1,500-hp. engines and a 48-car coal-thawing house. These recent additions require chiefly steam rather than electricity, so that the present power plant, although retaining the original generating equipment, has a strictly modern boiler room designed to handle sudden and large variations in steam demand.

O. H. Hagerman, as manager of the marine department, has general supervision over the terminal. George W. Supplee is superintendent, and Robert L. Johnson chief operating engineer.

Fig. 1—Original generating equipment, installed in 1910 and still in operation, comprises two 937-kva. turbo-generators and two 750-kva. rotary converters.

Fig. 2—Three recently installed 10,000-sq.ft. water-tube boilers with traveling grate stokers. The new boilers are automatically controlled.

Fig. 3—View of plant, showing 200-ft. stack.

Fig. 4—Instruments grouped on board in turbine room measure steam production and distribution, feed and flue temperatures, etc.

Fig. 5—Chemical tank and proportioner of large hot-process water-softening system.

Fig. 6—Watch engineer testing water from filters of softener.

Fig. 7—Sedimentation tank 21 ft. high softens entire feed supply.

New Boiler Equipment Shows Advance in Boiler Room Practice*

Within Fixed Limits Set by Existing Building Columns, Modern Boiler Setting Design Has Increased the Boiler Steam Output Almost Sixfold, and Improved Prime Movers Have Led to an Eightfold Increase in the Power Output per Boiler

THE boiler room of the Fifty-ninth Street power station of the Interborough Rapid Transit Co., in New York City, since its initial completion in 1905, has been conspicuous as a laboratory in which has been developed much that is good in present-day boiler room practice.

The original equipment consisted of 6,000-sq.ft. boilers with hand-fired grates, which did not permit the boilers to be operated much in excess of 100 per cent of rating. These furnished steam to the Manhattan-type engine-driven generators, and each boiler was able to produce about 1,000 kw. Soon after the station was completed the original hand-fired grates were replaced by Roney stokers, which reduced the labor cost, increased the efficiency and enabled the boilers to be operated at somewhat higher capacity. In 1910 additional capacity was imperative, and Roney stokers were installed under the rear of eighteen of the boilers to supplement the stokers already operating under the front end. With this equipment the boilers were operated without difficulty at twice their normal rated capacity. This, together with the addition of low-pressure turbines and surface condensers operating on the engine exhaust, increased the output per boiler to about 2,200 kw.

Later underfeed stokers were substituted for all of the single Roney stokers and for six of the eighteen double units, leaving twelve double units in use in 1919. Up to this time no additional boilers had been installed, although the capacity of the station had been more than doubled over the original installation.

At this time the capacity of each boiler was approximately 3,000 kw. A portion of this increase was due to the installation of large steam turbines and the use of superheaters in the boiler room. Recently more capacity has been demanded, and the entire question has been the subject of very careful consideration.

The boiler room was originally designed to house six

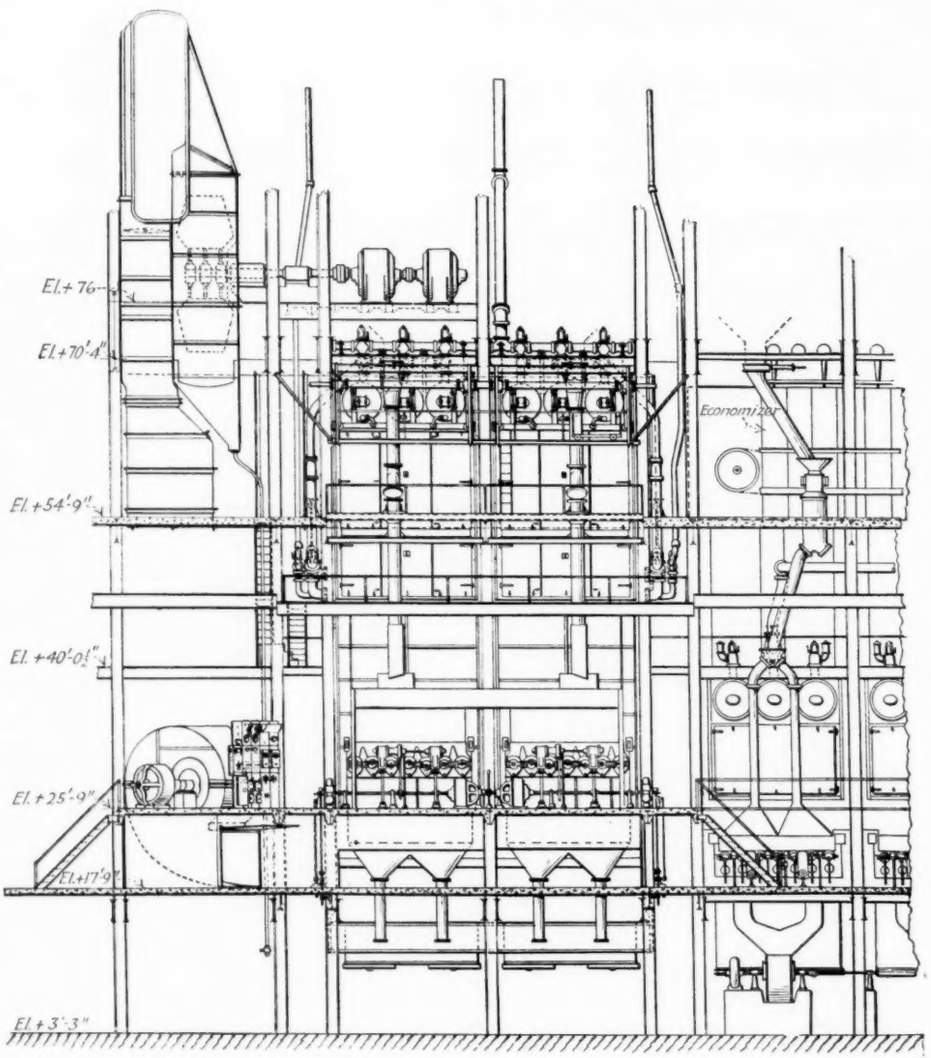


Fig. 1—The new boilers (center) are set 30 ft. higher than the old ones (right), and between building columns on the same spacing

*The information for this article is drawn from a paper presented by H. B. Reynolds and R. S. Lane, of the Interborough Rapid Transit Co., and J. M. Taggart, consulting engineer of Taggart & Perry, before the Metropolitan Section, A.S.M.E., on Feb. 24, 1926. The paper is printed in full in *Mechanical Engineering* for March, 1926, pages 246 to 250.

sections of boilers, each section consisting of twelve 6,000-sq.ft. boilers with breechings discharging into one stack. Initially only five sections were installed. In these original installations the boilers are set comparatively low, with economizers above them, as indicated at the right in Fig. 1.

It was finally decided to secure the additional capacity by installing new boilers and stokers in a portion of the vacant sixth section at the west end of the boiler room. Since this portion of the building was designed and constructed exactly like the others, it was necessary to design the new installation to suit existing building columns. The removal of the economizer floor gave ample headroom, but the lateral dimensions were fixed.

The new boilers are designed to develop the equivalent of some 7,000 or 8,000 kw. each. The boiler selected is of the horizontal longitudinal-drum inclined-tube vertical-header type, twenty-one sections wide and twenty-four tubes high, with three longitudinal drums,

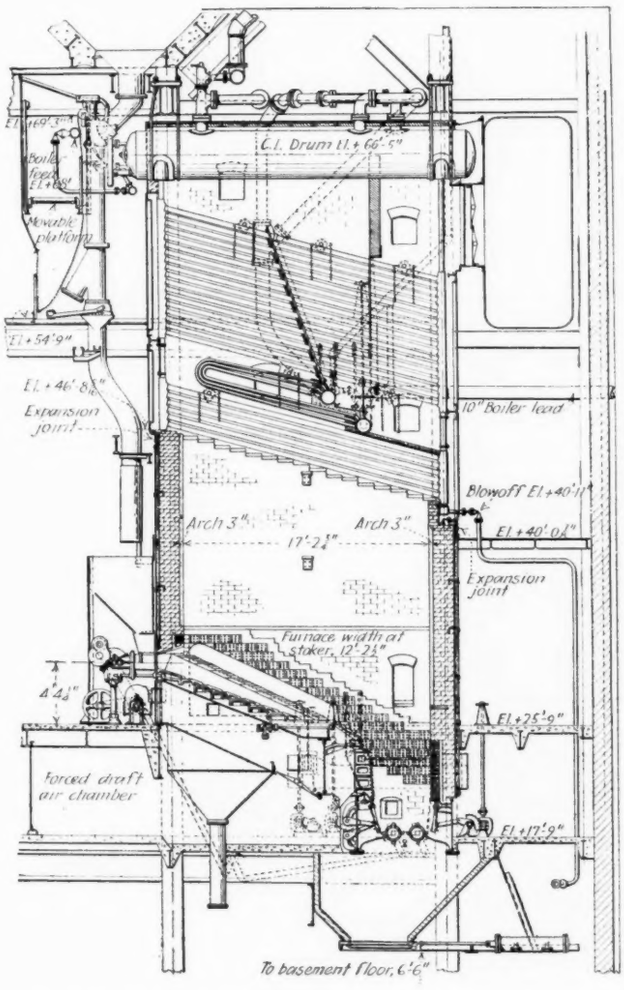


Fig. 2—The long stoker and high boiler (the highest ever installed over a stoker) give a simple setting

the tubes being 20 ft. long and 4 in. in diameter, giving a total heating surface of 11,400 sq.ft. per boiler. These new boilers are the highest that have ever been installed over a stoker. The development, however, is logical, in view of the increasing length of stokers. The ratio between the boiler surface and the grate surface in this installation is almost the same as in the case of the old fourteen tube high boiler with seventeen tuyere stokers. The front view of two of the new boilers is shown in the center of Fig. 1, and a section of the setting is shown in Fig. 2.

To obtain uniform feed water supply to all three drums and to equalize the water levels, individual drum

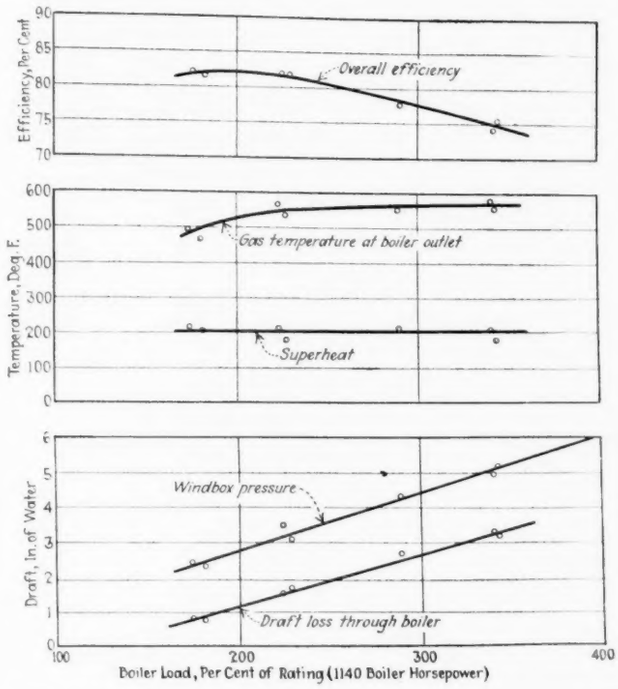


Fig. 3—Test results show that the efficiency is excellent, with practically perfect superheating characteristics

checks are omitted and the feed pipes to each drum are connected to a relatively large short header across the front of the drum. Water is fed to this header at two points through non-return stop valves and hand-operated regulating valves.

The stokers are of the Taylor HC7 type, seven retorts wide by thirty-seven tuyeres long, with double-roll clinker grinders. Six pushers, shown in Fig. 2, form the bottom of each retort and continuously agitate the fuel bed and advance the fuel slowly toward the grinder pit.

Owing to the space limitations, adequate protection of the building steel presented a difficult problem. One or two sides of each column are exposed, with an air space between the brick and the remaining sides. The vertical furnace walls are arched or bulged outward slightly from the stoker up to the boiler tubes. Perforated Bernitz blocks are installed in all four walls up to the fire line.

Due to the location of columns, it is necessary to place the boilers in groups of two, with a passageway on only one side of each boiler. However, as far as the settings are concerned, the boilers are entirely independent, a space of about 3 in. being left between the boilers of each pair. In future installations it is believed that it will prove desirable to install a single boiler in place of a pair of boilers. This, however, is contingent upon the development of an acceptable design for protecting the center building column against excessive temperature rise.

The stokers are considerably longer than might be considered normal practice, and the clinker grinder pit

is much deeper than any heretofore installed. This results in very complete burning out of the refuse, and experience indicates that the temperature of ash at the grinder is low. Quenching with water is seldom necessary. The grinders are run continuously with little adjustment at a speed that varies with the stoker speed, since they are driven from the same shaft.

All of the furnace walls are made up of ¼-in. steel sheathing with 2½ in. of Sil-o-Cel insulation carried on the sheathing framework, a layer of asbestos millboard and a firebrick wall varying from 13½ to 18½ in. thick in the side walls and from 19 to 24 in. thick in the front and rear walls.

Fig. 1, at the left, shows the arrangement of forced and induced draft fans. The forced draft fans are arranged to discharge through swinging dampers, balanced to open or close with the pressure, into an air duct so arranged that the discharge of each blower can be confined to one battery of boilers, but it is expected to operate with panels removed from a partition so that one or two blowers can be used for four boilers, depending upon the load. The blowers have been located and designed for preheated air, should heaters later be installed.

The flue gas from each pair of boilers discharges into a common flue leading to the induced draft fan, or through a bypass damper directly to the stack. Each induced draft fan is fitted with two squirrel-cage motors, one of 715-hp. capacity and a speed of 180 r.p.m., the other of 350-hp. capacity and a speed of 240 r.p.m. Only one motor is used at a time, the other running idle. The purpose is to provide spare equipment and at the same time furnish simple and economical speed control instead of using uneconomical or expensive variable speed motors. Close adjustment of draft is had by motor-operated dampers. An automatic controller maintains constant suction in the furnace.

An instrument board brings together the various motor controls, with a Bailey boiler meter and draft gages for each boiler. Recording thermometers respond to flue gas steam temperatures, thus giving a record of the condition of the boiler and superheater surface.

After the installation was completed one of the units was subjected to an extensive test. This has been reported fully elsewhere,* and it is perhaps sufficient to say that the curves of Fig. 3 indicate the over-all results, which are obviously good, and serve to support the well-recognized fact that increased capacity does not necessarily call for a sacrifice of economy.

**Mechanical Engineering*, March 1926, pages 246 to 250.

How a Direct-Current Motor Operates

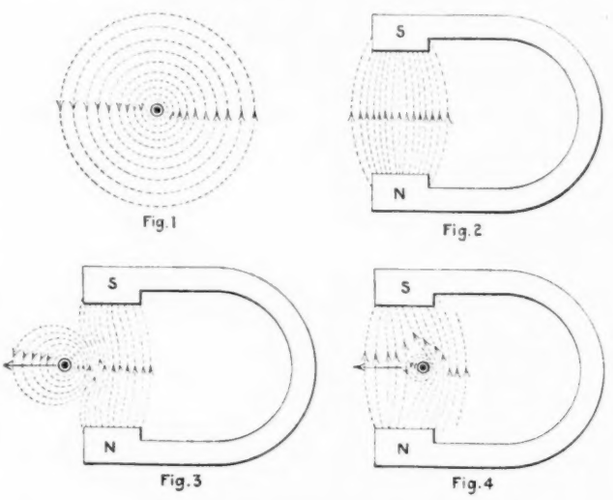
A Simple Explanation of What Takes Place in a Direct-Current Motor to Make the Armature Revolve and How the Current Is Regulated to Meet the Demands of Load Changes

By A. A. FREDERICKS

A DIRECT-CURRENT MOTOR operates on the fundamental principle: A conductor carrying a current through a magnetic field tends to move in a direction to cut the line of magnetic flux. A current flowing in a conductor produces a magnetic field that takes the form of concentric circles about the wire. The direction of this field depends upon the direction of the current. When it is flowing toward the reader, the magnetic field has a counterclockwise direction as in Fig. 1. Reversing the direction of the current reverses the direction of the magnetic field—that is, it has a clockwise direction.

In a horseshoe magnet the field between the two poles will have a shape somewhat like that indicated in Fig. 2. The bulging of the lines between the field poles is caused by their repelling each other and tending to separate. If a conductor with a current flowing in it, as in Fig. 1, is brought into the influence of the field from a magnet as in Fig. 3, there will be a repulsion between the two fields. Between the conductor and the magnet the two fields have the same direction and have a tendency to make the magnetic field more dense at this point, which would result in an increased repulsion between the lines of force. Another way of looking at this is: as the field of the conductor moves around and comes into contact with that of the magnet the two have a wedging action that tends to push the conductor to the left in the direction of the arrow and the magnet's field to the right.

If the conductor is placed in the magnet's field, as in Fig. 4, it will have a tendency to move in the same direction as in Fig. 3. On the left-hand side of the conductor the lines of force are moving down, or in opposition to the direction of those from the magnet. Therefore, on this side of the conductor the two fields oppose and the field of the magnet will be reduced. On the right-hand side of the conductor the two fields are in the same direction and will increase the density, which will result in a tendency to move the conductor into the weaker field, or to the left, as indicated in the



Figs. 1 to 4—Illustrate the fundamental principle of an electric motor

figure. Another way of looking at this is to consider the lines of force as elastic bands. On the right-hand side of the conductor the lines from the magnet have been distorted to the right by the field about the conductor. In doing this a force has been produced that will tend to push the conductor to the left. If either the direction of the current in the conductor or the direction of the magnetic field is reversed, the direction of the conductor's motion will be reversed.

Knowing the direction of the lines of force and the direction of the current, a rule for determining the

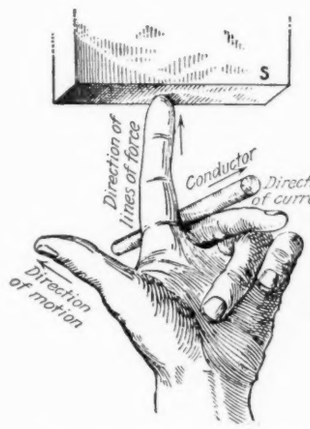


Fig. 5—Left-hand rule for direction of a motor

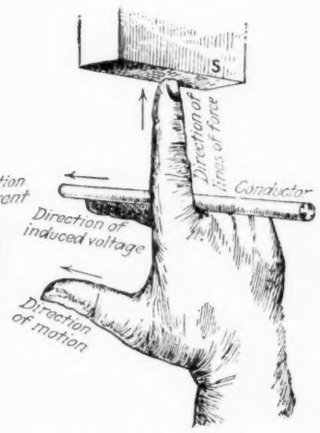


Fig. 6—Right-hand rule for direction of voltage

direction in which the conductor will tend to move is shown in Fig. 5. Using the left hand and placing the thumb, forefinger and middle finger at right angles, as indicated, if the forefinger points to the direction of the lines of force and the middle finger to the direction of the current in the conductor, then the thumb will point to the direction in which the conductor will tend to move. The arrangement in Fig. 5 represents the conditions in Figs. 3 and 4—that is, the forefinger points upward for the direction of the field of the magnet, the middle finger points toward the reader for the direction of the current and the thumb indicates the motion of the conductor to be to the left, as in Fig. 4.

If the hand, Fig. 5, is revolved through 180 deg., the middle finger will point away from the reader and the thumb will point to the right. This is the equivalent of reversing the direction of the current in the conductor, and would result in a reversal of its direction across the magnetic field. Keeping the middle finger pointing toward the reader and turning the hand until the forefinger points downward, the thumb will then point to the right. This movement is the equivalent of changing the direction of the magnetic field without changing the direction of the current in the conductor and results in a reversal of the direction in which the conductor tends to move. Turning the hand so that the middle finger points away from the reader and the forefinger points down will still leave the thumb pointing to the left. This movement of the hand is the equivalent of reversing the direction of the magnetic field and the current in the conductor, but this does not reverse the direction in which the conductor tends to move.

From the foregoing it may be deduced that if the direction of the current is reversed through the armature of a motor, the armature's direction of rotation will be reversed. Changing the direction of the current through the field winding of the motor will change the direction of the lines of force in the field poles and will result in reversal of the armature's direction of rotation. If the direction of the current in both the armature and field coils is reversed, then the direction of the armature's motion will not be reversed.

How the foregoing rules may be applied to a motor is indicated in Fig. 7. For simplicity the armature is represented as being of the ring type, but the same effects that can be produced with this type of armature are true for the drum type that is in general use today. With a current flowing through the field coils as shown by the arrowheads, the polarity of the field poles will be as indicated by the letters *N* and *S*. With the left-hand brush connected to the positive line and the right-hand one to the negative, current will flow through the armature winding as indicated by the arrowheads.

Considering the lower half of the armature, Fig. 7, it will be seen that current is flowing toward the reader on the outside surface of the core and away from the reader as the inside surface. The conductors on the inside surface are not effective, since the lines of force do not pass out of the core around them, except to a very limited extent. In the outside surface conductor, the current is flowing toward the reader and the lines of force are upward, which is similar to the conditions in Figs. 1 to 4; therefore the conductors will tend to move in the same direction in both cases, or to the left, indicated by the curved arrow, Fig. 7. This direction

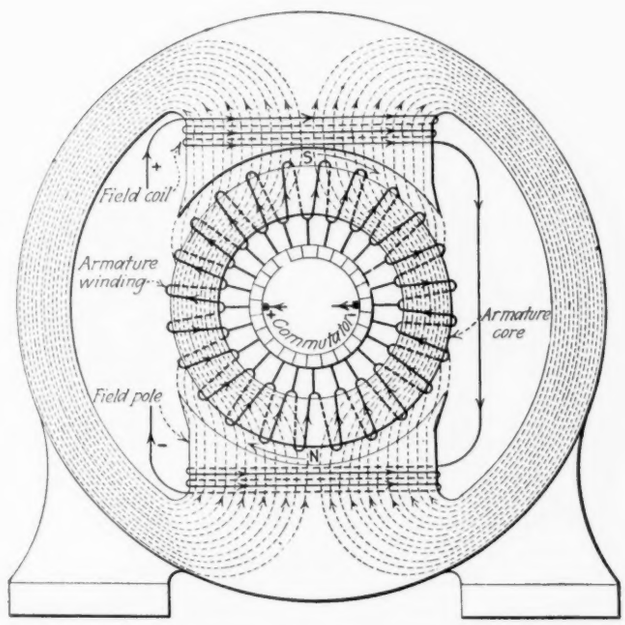


Fig. 7—Diagram of a direct-current motor

can be checked in Fig. 7 by applying the left-hand rule, Fig. 5. In Fig. 7 the current in the conductor is flowing toward the reader; therefore the middle finger of the left hand will point in that direction. The direction of the lines of force is upward, and the forefinger will point in that direction, with the result that the thumb will be pointing to the left, the direction of rotation indicated by the curved arrow.

On the top half of the armature the direction of the current in the conductors on the outside surface of the core is away from the reader, with the line of force

in an upward direction. Applying the rule for the direction of motion, it will be found to be to the right, or the opposite to that for the bottom half of the armature. This is just as it should be, since the direction of the current in the top half of the armature is opposite to that in the conductors on the lower half. However, the combined effect of the conductors on the two halves of the armature is to produce a clockwise rotation.

If the right-hand brush were to be connected to the positive side of the line and the left-hand to the negative, the direction of the current through the armature conductors would be reversed and would give a reverse direction of rotation from that shown in Fig. 7. Or if the direction of the current in the armature is allowed to remain as in the figure but the direction of the current is reversed in the field coils, then the direction of the magnetic line of the field poles would be reversed, which would reverse the armature's rotation. Any of these effects may be easily checked with the rule given in Fig. 5.

Consider the armature rotating in the direction indicated in Fig. 7, then the conductors on the top half of the armature will be cutting across the magnetic field to the right, whereas those on the bottom half will be moving to the left. Moving the conductors across a magnetic field produces the fundamental conditions to generate a voltage—that is, whenever a conductor is moved in a magnetic field so as to cut the lines of force, a voltage will be developed between its terminals. The direction of this voltage will bear a relation to the direction of the lines of force and motion of the conductor such as that indicated in Fig. 6. Placing the thumb, forefinger and middle finger of the right hand at right angles, if the forefinger indicates the direction of lines of force, and the thumb the direction of motion of the conductor, the middle finger will point to the direction of the voltage or current.

Applying the rule, Fig. 6, to the direction of the magnetic field and the motion of the conductors indicated in Fig. 7, it will be found that the voltage generated in the conductors on the outside surface of the armature is in opposition to the voltage applied to the brushes on the commutator. For the reason that the voltage generated in the armature conductors is opposed to the applied voltage, it is known as a counter-electromotive force. This counter-voltage is almost equal to the applied voltage, and the difference between the two is effective in causing a current to flow through the armature winding.

For example, assume that the applied voltage is 120 and the counter-electromotive force is 117 volts, then there are $120 - 117 = 3$ volts effective to cause a current to flow through the armature winding. If the winding has a resistance of 0.5 ohm, then the current taken by the armature equals $3 \div 0.5 = 6$ amp. If the load is increased on the machine, the armature's speed will decrease a small amount. A reduction in speed will cause a reduction in the counter-electromotive force and allow more current to flow through the armature conductors and increase the turning effort to drive the load. Assume that the increase in load slowed the armature down to where the counter-electromotive force is 113 volts, then the effective volts are $120 - 113 = 7$, and the current flowing in the armature conductors has increased to $7 \div 0.5 = 14$ amp. If the load is removed, the speed of the machine will increase to where the counter-electromotive force reaches a value that will allow only current enough to flow in the winding to produce the necessary torque to drive the armatures at no load.

From the foregoing it is seen that the counter-electromotive force generated in the armature conductors controls the amount of current taken by the armature from the line. As the load is increased the armature slows down; in doing so it reduces the counter-electromotive force and allows more current to flow. If the load is reduced, the armature increases in speed and increases the counter-electromotive force, thus decreasing the current in the armature. In this way at all times the current flowing in the armature winding is regulated to produce just sufficient torque to carry the load.

Lubricating Stoker Bearings

Bearings in a stoker installation are internal and external in location. Internal bearings usually get little or no lubrication; in fact, they are generally built with relatively high clearances, to operate without oil. The amount of motion to which they are subject is relatively slight, as is also the comparative rubbing speed. Therefore heat conditions are really the only detriments involved.

External bearings, however, should receive careful attention. Frequently they are designed for grease lubrication, being equipped with suitable grease cups or fittings for pressure lubrication.

Equipment of this type is advantageous in that it is usually dustproof and insures a supply of clean lubricant to the bearing surfaces. Grease also tends to work out toward the end of the bearing, thus preventing the entry of dust along the shaft. For such service a medium bodied compression cup grease free from thickeners or non-lubricating adulterants will function best.

It is also important to remember that in certain stokers the bearings of at least part of the gear shafting involved will be designed for lubrication by the same lubricant as serves the gears. This materially simplifies the problem from a labor point of view and also insures the bearings of more positive lubrication than where periodic attention is necessary. It necessitates, however, more careful selection of the lubricant, for the requirements of both gear teeth and bearings must be adequately met. Unless pressures and temperatures are abnormal, a straight mineral 500 viscosity oil will in general serve the purpose.

Elsewhere it is also possible to lubricate other stoker bearings with oil, and this is often done where it is desirable to use one product for the external bearings of both the prime mover and the stoker. In such cases a medium viscosity engine oil of about 300 sec. viscosity Saybolt at 100 deg. F. will be suitable.—*Lubrication.*

Natural gas is generally found in connection with crude oil and occurs in two different forms. What is known as casinghead gas is discharged from oil wells with the oil. This gas contains from 1 to 3 gal. of gasoline per thousand cubic feet and after the gasoline has been recovered by passing the gas through oil-absorption plants, the resulting dry gas has a calorific value of about 1,200 B.t.u. per cubic foot. The other form is known as dry gas and comes from gas-bearing sands located above the oil sands. It contains no gasoline. Its heat content is approximately 985 B.t.u. per cubic foot. The so-called rock pressures of these sands vary from 300 to 5,000 lb. per square inch.

Turbine Performance Data

IT IS common knowledge that turbine buckets and nozzles become rough as they grow older. Erosion of the metal by wet steam and the accumulation of deposits of scale often develop to an astonishing degree. These must inevitably affect the steam rate of the machine, through increasing surface friction and through the setting up of irregular eddies in the steam flow.

Concerning the extent of this effect, however, there is little reliable information available. It is with pleasure that *Power* presents on another page of this issue a report of dependable tests covering a long period. While the data will be of most value to those who designed the turbines, they are not without value to every engineer. In a growing system, with new turbines added from time to time, as is the case with the larger central stations of today, and with a demand for ever-increasing economy, a steady increase in steam rate must quickly relegate a turbine to the status of a stand-by unit, to be run only for peak-load periods and in emergencies.

The bearing of this on the small plant is in the direction of maintenance. An increase of one or two per cent in the steam rate of a turbine results in a like increase in the coal bill, and may easily be sufficient to pay for the replacement of buckets which have been subject to the more severe ravages of time.

The meagerness of data on this subject leads one to wish that others would present the results of similar studies. Perhaps it might be possible ultimately to establish fairly dependable figures for the annual rate of increase of steam consumption for various types of turbines.

Increased Capacity in the Same Old Space

IT HAS BEEN SAID that he who makes two blades of grass grow where one grew before is a benefactor of the human race. What shall we say of the engineer who designs a boiler setting to produce almost six times as much steam as was produced by a boiler installed twenty-one years ago within the confines of exactly the same building columns?

When Mr. Stott designed the Fifty-ninth Street power station of the Interborough Rapid Transit Co., it was an embodiment of the best engineering practice available at that time. It is a striking thing to consider that twenty-one years ago the best current practice dictated the installation of large reciprocating engine-driven generators, and boilers of 600-hp. rating, with hand-fired grates. Under similar conditions of service and operation, such a design would be unthinkable today. Within the memory of men still young the advancement in plant design practice has been little short of astounding.

Through successive changes in this particular station the steam output of the boilers originally installed was increased about twofold by the installation of stoker equipment. Recently still further capacity was demanded, and a new boiler has been designed to fit between the same building columns and to deliver almost six times as much steam as was obtainable from the original hand-fired boilers occupying the same space.

During this period the prime movers have been progressively improved, first by installing low-pressure turbines operating on the exhaust of the reciprocating engine units, and then by the substitution of large turbo-generators for some of the reciprocating engine sets. This improvement in steam utilization, together with the boiler improvements, has resulted in the possibility of developing eight times the electrical energy per unit of boiler room area. The increase in electrical energy per unit of turbine room area would be still more pronounced.

All of this is in the direction of smaller plant buildings and lower first cost. Along with the constant striving after high economy, it is well to remember the importance of cost, and the latest installation at Fifty-ninth Street, discussed on another page of this issue, is an excellent example of how both ends may be accomplished through good engineering design.

Power Plant Needs a Clean-Up Week

EACH springtime hundreds of towns mark on the calendar a clean-up week, during which time the old-tin-can accumulation is removed from the garden corner, ashes are hauled off, and the place is given a clean face to present to the coming summer.

Engineers could well afford to apply this clean-up week idea to their power plants. Outside of a minority, composed in the main of the larger plants, it must be confessed that a good housekeeper on dropping into a neighboring power plant could find plenty of dirt to make fly. Certainly the visitor does get an unsavory opinion of the ability of the engineer when he encounters a pile of empty oil barrels close to the engine-room door, and two or more barrels, partly filled, jammed against a cylinder head or the edge of a switchboard. The slopping of oil on the floor is a common habit, if one is to judge by the condition of a great many engine rooms. Neither is it easy to explain the tendency of so many operators partly to dismantle some worn-out machine and then to give up in disgust—or is it because of sheer laziness that so many parts lie scattered about?

Who was it that discovered that a piece of lumber braced against a belt would keep the belt on the pulley? At any rate, he has been copied by many who hold engineers' licenses. It is a pity the idea was not patented by the original clever brain so that it could not be infringed.

Neither does an odd pair or so of overalls thrown across a broken chair or flung at a nail on the wall help to give a parlor appearance.

There might be some excuse for a small amount of dust in the boiler room. The trouble is, many firemen have thrown away their brooms in despair. The permissible little disorder has been allowed to become a mountain of ashes, cinders and broken brickbats. The fire tools are thrown about on the floor, even though convenient pegs or spikes be in the wall.

The visitor is unable to see how many furnace walls are partly down; but judging by the number of unmended ashpit and fire doors, the brick mason is needed in about one out of every two plants to rebuild the walls and arches.

There is more or less a tradition that a power plant is a dirty place. This may be true in some degree of small plants where the owner will not even provide a cement or brick floor; but even here the engineer can keep things in order. In large plants it is easy to have the place in shipshape condition. The whole trouble is that too many men let down—they have so little to do that they end by doing nothing. Surely, a power plant clean-up week should be the order of the day.

The Proposed Sixth Great Lake

ONE of the outstanding national issues in this country and Canada is utilization of the Great Lakes and St. Lawrence waterways. Why this should be is readily appreciated when it is considered that on the Niagara and St. Lawrence rivers there are possibilities of developing about ten million horsepower and the freight carried each year from Lake Superior to Lake Huron and in the opposite direction is approximately one hundred million tons. Neglecting all other considerations, these figures are of proportions worthy of the attention of the best engineering, business and national thought of Canada and the United States. A deficiency in rainfall for the last seven years, coupled with artificial conditions, has caused a serious lowering of the lakes' levels and this has led to various suggestions for restoring them to normal conditions.

One of the most ambitious of these restoration schemes is to create a sixth Great Lake and turn the course of rivers, that now flow to Hudson Bay, into Lake Nipigon and the Great Lakes system, as explained elsewhere in this issue. From the meager information available on this project, it must be admitted that it has certain possibilities, but whether these embrace all that its sponsor claims is still an open question. The region is one on which very little definite data are available, and until more are obtained by actual surveys it may be impossible to pass final judgment. The sponsor is an experienced engineer, and probably is as familiar with the region as is anyone else, and maybe more so, but more than this is required to pass upon the project.

As the surface of the proposed new lake would be about one thousand feet above sea level and the water would flow down through the Niagara and St. Lawrence waterways, the plan has great power possibilities, in addition to restoring the lakes' levels. But this water for power purposes will probably not be required for many years, at least in the St. Lawrence; furthermore, if a revision of the treaty for diversion at Niagara is obtained, it will not be required at that site for a long time; therefore the chief benefits that may be claimed for it at present are for navigation. The lakes' levels can be controlled by other means at about one-fifth the cost of the proposed sixth Great Lake scheme, which fact may militate against the latter.

The provinces of Ontario and Quebec must depend upon imported fuel, therefore water power has been a vital factor in their industrial development. After all the present available water power within easy reach of these industrial regions is utilized, great economic progress will be made if the water running to waste in some of the out-of-the-way places of the North can be caused to flow into the districts where it can be put to work. In this respect the sixth Great Lake scheme may offer its greatest possibilities, if it is at all feasible.

Advances in the Art of Fusion Welding

ON PAGE 438 of this issue are reported two highly interesting developments in the art of fusion welding. In spite of the fact that both processes employ hydrogen in connection with an electric arc and were developed simultaneously in research laboratories of the same company, they differ considerably.

The more interesting process, from the viewpoint of pure science at least, is that in which all the direct heat for welding comes from a flame of "atomic" hydrogen produced without the aid of oxygen. In the atomic-hydrogen torch the arc serves merely to split the molecules in a jet of hydrogen. The atoms later come together to form molecules, thereby producing intense heat. But in this process the hydrogen is more than the source (or, if one prefers, the vehicle) of the welding heat; it bathes the portion of the work being welded, excluding air and thus preventing the formation of oxides and nitrides that would weaken the weld. It is also claimed that the hot hydrogen quickly reduces to pure metal any particles of oxide that may happen to exist in the fused metal.

The other process referred to uses a single electrode, a direct-current arc being formed between it and the work. Here the arc is the direct source of welding heat. The metal is bathed with hydrogen, as before, to exclude air and eliminate impurities, but any change from molecular to atomic hydrogen and back again is more or less incidental.

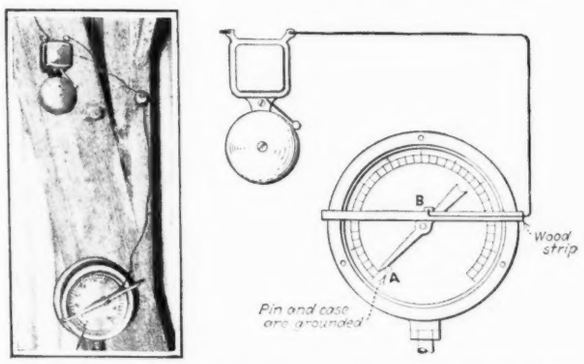
The claim is made that welds of uniform and extraordinary ductility are produced by both of these processes, these claims being supported by twisting and bending tests made on small specimens.

The question arises as to whether the use of a hydrogen-arc process will assure the safety of welded pressure vessels, a matter that is now being agitated in connection with the tentative Code for Unfired Pressure Vessels prepared by the A.S.M.E. Boiler Code Committee. If existing differences of opinion arise from the difficulty of insuring the absence of oxides and nitrides from the weld, the new processes (taking the claims at face value) might eliminate the uncertainty. To the extent that the reliability of welded pressure vessels is dependent upon the incidental heat-treatment of and the setting up of internal stresses in the weld and adjacent metal, the effect of the new processes is not so clear. Results of tests on complete pressure vessels will therefore be awaited with considerable interest.

Practical Ideas From Practical Men

Low Water Alarm

In the municipal light and ice plant at Lake City, Fla., the cooling water for the condenser is obtained from a lake about one-half mile from the plant. The motor-driven centrifugal pump placed at the lake at times stops due to a voltage drop opening the no-voltage release. The engineer had no way of telling when the



At left—Low water alarm. At right—Method of attaching contact

pump had stopped until the high ammonia discharge pressure opened the relief valve at the compressor.

To permit detection of pump stoppage, he installed an electric alarm shown in the accompanying illustrations and connected it to the water-pressure gage. A wooden strip was fastened across the dial face, and a brass contact point *B*, attached to the stick, projects through a hole in the glass until it touches the gage pointer when the pressure drops to zero. One of the terminals of the alarm battery is grounded, as is also the gage case. Whenever the pump stops, the water pressure gage pointer turns to zero and the alarm bell immediately rings. L. H. MORRISON.

New York City.

A Few Precautions in Welding

Notwithstanding the fact that the welding torch and the accompanying cylinders of gas are still considered more or less dangerous by the layman, the present-day welding equipment is safe, if properly handled. The old acetylene generators and even the storage tanks were prone to start for parts unknown until inventors solved the problem of safe generation of the gas and its storage in cylinders. The cylinders now are filled with asbestos saturated with acetone, which prevents the voids from containing air and the acetylene from decomposing into its elements when subjected to pressure. Present-day containers for acetylene, therefore, may be considered safe.

Some of the various precautions that tend to make use of the torch as safe as that of other tools in the power plant may be enumerated as follows:

Do not test for leaks with a flame; use the nose to detect the leak, and when it is discovered that gas is escaping, shut off the tank and stop the leak. Avoid kinking the hose, and keep it out of the way of hot metal.

Do not put oil in, on or even near any of the parts containing or controlling oxygen; do not handle these parts with greasy hands or gloves.

Be sure the torch is out and the tank turned off before leaving them.

Do not drop or jar the cylinders and do not leave them in the sun or subject them to other sources of heat.

Always stand the acetylene cylinder in an upright position.

Keep dirt out; blow out the cylinder end of the reducing valve union with a little of the gas from the tank.

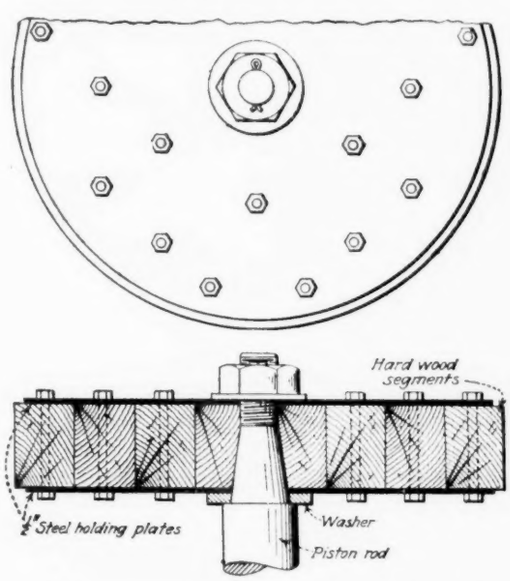
If the reducing valves do not hold the pressure as set, send them in for overhauling.

Be sure to connect the hose correctly to the torch, that is, acet. to A and O to O, as marked on the valve. Do not adjust the flame without using glasses.

Vermillion, S. Dak. L. A. COWLES.

Emergency Piston Repair

While in charge of a small steam plant in the Canadian Northwest, a cast-iron piston of a vertical steam engine broke into small pieces. Owing to the distance from the manufacturers or the nearest foundry, a new one could not be obtained for several weeks. Fortunately no damage was done to the cylinder or the piston rod, so I cast about for a means to get by, as owing to the nearness of winter it was imperative that



Well-seasoned beech blocks were used for body of piston

the engine be put back into service at the earliest possible moment.

Having recollections of a marine repair being made with a wooden piston, I decided that this expedient would have to be resorted to. Two ½-in. steel plates were cut out, about 1 in. less than the diameter of the cylinder; these were for the top and bottom plates of the piston. For the body of the piston I decided to use well-seasoned beech blocks, of which we had a supply on hand. These were cut into segments, which on assembly were circular and of a diameter a little larger than the cylinder.

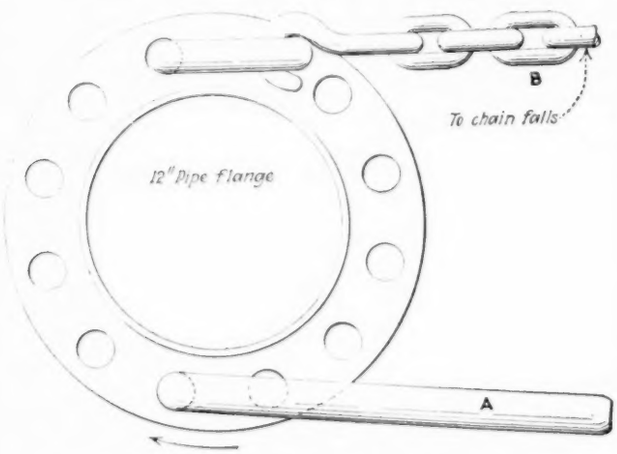
As the engine was used to run a lathe in addition to other machines, we were without motive power to machine the piston. However, the piston was assembled, bolted together with ⅝-in. bolts, and the whole chucked in the lathe. The lathe was then turned by hand, and the piston bored out for the rod. A rough cut was also taken off the beech blocks, which were finally finished off with a file and coarse sandpaper to a sliding fit in the cylinder. The rod was then entered through the piston with faced washers at the top and bottom and a cotter pin was put through the rod to prevent the nut slacking back.

Under a reduced steam pressure this piston did the work satisfactorily for more than a month, until a new piston could be brought in by team and canoe. After a few days' run, we increased the economy somewhat by turning a few small grooves in the wood blocks and lapping them with a few turns of hemp twine.

Hollywood, Calif. MAURICE C. COCKSHOTT.

Installing a 12-In. Flange in Close Quarters

A line of 12-in. pipe 125 ft. long is utilized to convey steam at 5 lb. pressure through a tunnel from the engine room to a large building that comprises a portion of my plant. One of the flanges in this line failed,



Flange was installed with the aid of a sledge and chainfalls

hence it was necessary to renew it. The bolts were taken out and the broken part removed.

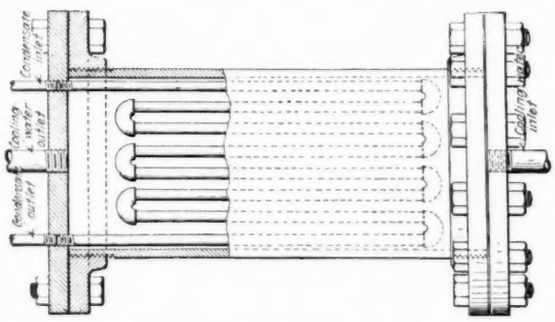
A new one was screwed on by hand as far as possible. A piece of round iron, *A*, 1 in. in diameter was secured, and 3 in. of one end was turned at right angles and inserted in one of the holes. A heavy sledge was utilized to drive on the end of this iron, thus turning the flange on until it was quite tight. By this means it was given about two turns more, by using the several holes as they came in proper position to give the best leverage, but this was not considered satisfactory. A set of chain falls was attached to the flange as indicated at *B*, and this made it possible to give the flange about one more turn. W. H. WAKEMAN.

New Haven, Conn.

An Improvised Heat Exchanger

The plant with which I am connected is well equipped with water-softening equipment, but we are able to feed chemicals to the softener only while makeup water is being added, due to the lime and soda solutions being pumped by the operation of rams through which the makeup passes.

A large portion of the time it is necessary to use such large amounts of injection water on one vacuum



Heat exchanger made from odd pipe fittings

pump that little makeup water is needed at the softener, with serious under treatment as the result.

To overcome this condition we made up a heat exchanger, as shown in the illustration, from odd pipe fittings available at the plant. The cooling water inlet and outlet connections were made 2 in. to correspond with the makeup water line from the mill supply system to the heater, and the exchanger was installed on a bypass in this line, letting all the makeup water pass through the body of the exchanger.

The condensate connections to the internal coils were made 1 in. and the inlet was connected to the condensate return line between the vacuum pumps and the heater, which is under the head pressure of the heater. The outlet was connected into the suction of the vacuum pumps in the usual manner.

The fact that we are not adding any of our boiler-feed makeup at the vacuum pumps keeps the rams in operation all the time, giving a continuous supply of cooling water for the heat exchanger and making absolute control of the water softener possible, with no raw water entering the system.

The use of the makup water for cooling purposes makes the system practically 100 per cent efficient thermally, and the regulation of a valve in the injection line at the pump makes it possible to pump only the amount of water necessary for sufficient cooling of the vacuum pump suction.

We used a blind flange instead of a cap, with the idea of being able to clean out the exchanger easily, but find that the temperature on the raw water side does not get high enough to cause any precipitation, and cleaning is rarely necessary. C. BARRY.

Kalamazoo, Mich.

Comments from Readers

Ammonia Condenser Pressures

During the last few years a much clearer understanding of the operation of ammonia condensers has been arrived at, and in continuance of this work the article in the Feb. 2 issue by H. J. Halterman is very instructive. However, to prevent the creation of erroneous ideas, some statements should be qualified.

In my opinion, properly designed common atmospheric, drip and double-pipe condensers differ little in action, because in each type from 50 to 70 per cent of the total ammonia liquefaction occurs in the pair of pipes in which the ammonia is in metal contact with the coldest water. This will be in the top of the atmospheric and drip types and in the bottom of the double-pipe type. With such conditions prevailing, the problem of counter-current flow of ammonia and water does not bear the importance of the problem of the prompt removal of the condensate after liquefaction.

The rule in regard to determining the approximate condenser pressure must be made conditional. For example, if 65 deg. F. initial water temperature is assumed, the head pressure arrived at, according to Mr. Halterman's rule, is 150 lb. gage. At this pressure the final water temperature is found in practice to be about 79 deg., a rise of 14 deg. If the water removes 240 B.t.u. per ton per minute, cooling water at the rate of about 2 gal. per ton per minute must be supplied, and the rule should be so qualified in order not to be misleading.

A more legitimate rule for the determination of the approximate condenser pressure is to refer to an ammonia table for the pressure corresponding to a temperature from 1 to 5 deg. F. greater than the final water temperature.

R. E. GOULD.

Urbana, Ill.

A Hydraulic Shock Test

The Feb. 16 issue of *Power* contained a partial report on the hydraulic shock test made on an electrically welded drum at the plant of the A. O. Smith Corp., Milwaukee, Wis. The results of the test are analyzed by Prof. T. M. Jasper, of the University of Illinois, who expresses the following opinion:

> There is no doubt that the fact that the vessel was unannealed resulted in initial stresses of considerable magnitude being present in the material, which stresses were in addition to those impressed by the test. These stresses, calculated from subsequent tests on similarly welded vessels, were undoubtedly in the neighborhood of 8,000 lb. per sq.in. I am convinced that proper normalizing or annealing would have reduced such initial stresses to a negligible quantity.
>
> Tests already performed by the writer show that when initial stresses are present in a metal to the extent of about 35,000 lb. per sq.in., annealing has relieved these stresses to such an extent that their importance is less than the fluctuation found in the ultimate strength values on adjacent metal in a plate.

It is highly satisfactory to us to have such a recognized authority as Professor Jasper point out the importance of properly annealing a vessel after it is completely fabricated.

With regard to tanks used at high operating temperature such as has to be met in cracking stills, Professor Jasper writes as follows:

> It is the opinion of the writer, based on experiments now in progress, that annealing is not necessary where vessels are to be used at or above 600 deg. F. for the reason that *the very conditions of operation have the effect of annealing the material in such vessels.*

The opinion that certain annealing effect takes place in vessels operated in service at elevated temperature we have likewise repeatedly expressed. Consequently, we have cautioned against the practice of basing the strength of cracking stills on yield-point figures obtained from testing unannealed material at elevated temperature, because the period of testing is too short to anneal the material thoroughly.

The authoritative information given by Professor Jasper that the operating conditions at elevated temperature have the effect of annealing the material would therefore make it essential that tests at elevated temperatures for yield point should be made on steel specimens that have been properly annealed.

We differ, however, with the opinion of Professor Jasper that on account of such annealing effect it is not necessary to anneal vessels for such service. If fiber stresses of 8,000 lb. per sq.in. are possible, due to unannealed material which is approximately 100 per cent increase in the permissible stress of the steel used for such tanks, it does not seem logical to put a tank into operation with 100 per cent stress increase to start with. Serious failures would be likely to occur following such practice, because unsafe stresses would exist in the shell before the effect of thorough annealing has had time to take place. This seems only to prove the necessity of annealing the tank very carefully.

New York City. F. LOEFFLER, Pres.,
Techno-Service Corporation.

Why Regulate the Coal Industry?

Just as we were congratulating ourselves upon the collapse of the coal strike, your foreword in the Feb. 23 issue takes all the joy out of it by telling us that when we thought we were sitting tight we were only sitting quiet.

But has not something been gained after all? Let us disregard for the moment the inconveniences of a temporary dislocation of trade and dealer profiteering and fix our attention upon fundamentals. Two monopolistic, organized interests, the mine owners and the mine workers, the latter dominated by a man of great personal ambitions, attempted to hold up the consumer and the latter was refused a hearing, even in the form of arbitration. But, fortunately, it was demonstrated that competition still exists in the supply of fuel, and it seems reasonable to assume that the foothold which competing fuels have gained will not be given up.

You say that the mining and distribution of coal are

public services and that "when the public knows how much that service costs, it can intelligently tell the owners and the operators and distributors how much they may make out of it, and the miners what proportion of it their wages shall be." Well, for the sake of the argument, suppose that the public, or rather its elected, or appointed, representatives, should decide to determine proper wages, fair charges and prices, how are they to go about it, and will they do it "intelligently"? Are they to rule that a man doing such and such work shall receive so and so much pay, or are they to leave it to the individual to decide whether the job of mining and the wages paid attract him more than some other job and its pay? Who is to say whether a miner should receive more than an editor, or *vice versa*, and which man is to follow which vocation? Similarly, are they to tell the man who saves that he must invest his money in mining for a specified return, or shall he be free to take his own choice of risks and earnings?

Looking to the future, the more industries one puts under arbitrary commission control, rather than under the natural automatic control of free competition, the more difficult it is going to be to establish just economic rewards for labor, saving and intelligence; in other words, the less liberty there will be for those of us outside the bureaucratic ring. The more that the open market for the buying and selling of effort and capital is curtailed, restricted and obstructed, the more matters will be determined by the political manouverings of blocs, classes and rings.

You say that the mining and distribution of coal is "charged with a public interest." So is everything affecting the lives of all of us, but the question as to what control should be exercised by the public is something else again. Is it to be expected that the price of coal will be less under a system of wages determined by voting power and profits fixed by manipulation, or under a system which places a premium upon effort, efficiency and enterprise? Before you arise to tell us what our wages, profits and prices shall be, will you please first explain in some detail what "tackle" you propose and what the "convictions" are that you intend to hitch it to that will give better results on the whole than a suitably safeguarded play of supply and demand? What is fairer than a market open to all alike?

New York City. GEORGE H. GIBSON.

Is This Condition Prevalent?

Please discontinue sending *Power* to me, and send your bill. The reason of this is I am not in the engineering game any more. I have found other lines of work pay very much better, and besides, there is less responsibility; in addition one does not need to work in some back out-of-the-way room that cannot be used for anything else but an engine or boiler room. Another thing; one likes to have a day once in a while to forget his dungeon and get a little sunshine and recreation without being compelled to give an itemized account as to where he is going to spend his time.

I was employed some years ago at a local institution when often I would work for seven months at a stretch without losing a day, and yet when I asked for more pay the reply was that "while we know you are worth more money, we can do nothing for you." They could not increase my pay, and yet they have been trying to get me to return since I resigned more than two years ago.

The position I now hold requires no more brains than is required to dig a ditch, and yet I receive 8c. per hour more than when I had charge of a battery of four boilers, seven pumps and was foreman of from five to seven men, with the responsibility of the upkeep of the whole. When a man spends fourteen years on the same job and gets no more consideration than I got it is time to look for something else. What say you?

I personally don't believe the game is worth the candle. CARL F. MILLER.

Mansfield, Ohio.

The Lecture Fetish

In the Feb. 2 issue an editorial entitled "The Lecture Fetish" deals with the abuse of the lecture system in colleges and technical schools, and advocates fewer lectures and more textbook drill. Perhaps a few remarks on the "Textbook Fetish" would not be out of order.

Although undoubtedly the exclusive use of the lecture method leads to unsatisfactory results, no teacher who has ideas of his own can be expected to spend his energies entirely in the effort to drill the contents of a textbook into the heads of his students, even when a satisfactory text is available, which is not always the case. It is suggested in the editorial that if the text is not satisfactory a new one be adopted or written. This sounds easy, but in fourteen years' teaching experience I have never found a single text to which I was willing to confine myself in teaching any subject. A few years ago I decided to remedy this situation by writing a text myself, but as soon as I began to use it I found at once the necessity of supplementing it with lectures. It was simply a case of mental growth and development of new ideas.

No teachable text can contain everything that should be included in a well-taught course. The attempt to be complete leads to unmanageable bulk and prohibitive cost. A shining example of this may be found in a recent book on Mechanics of Machinery which is the last word in thoroughness and painstaking scholarly analysis. This book is my constant source of material in preparing *lectures;* but it would be utterly impossible to use it as a text for a course of the limited length that is feasible here.

Another method of escaping the limitations of the single textbook would appear to be by assigned readings in other texts, journals, pamphlets, etc. However, there are serious difficulties in carrying out such a plan. Not the least of these is the fearful confusion in the matter of notation employed by different writers. This single factor often makes it practically impossible to refer students to some of the best sources. To make such information available without an unwarranted call on the time of the student it must be translated into symbols with which he is familiar. Obviously, this calls for the lecture method. If the student, like the instructor, confined his efforts to one special subject, he might properly be required to familiarize himself more with the literature of the subject, but ordinarily this would be too heavy a demand on his time. Every instructor realizes that in going over a new treatise he must cover much familiar ground in order to gain a new point of view on a few matters. He cannot expect the student to do likewise. The most feasible plan for giving the student the benefit of his readings outside

the text seems to be by digesting the new material in the form of lectures.

The fundamental error of those who condemn the lecture method, root and branch, and advocate the text-book drill in preference lies in the fact that colleges and technical schools are not dealing with a fixed body of knowledge, but with one that is constantly widening and changing, due in a considerable measure to the efforts of the college teachers themselves. Such teachers cannot be held down to the routine of transmitting the ideas of others, using methods that are standardized by school superintendents, boards of education, etc. They must be free to express their own thoughts and ideas and to vary the material taught continuously so as to keep abreast of new developments.

To avoid stagnation in our college teaching, the lecture method is indispensable as an integral part of the program of instruction.

Lawrence, Kan. JOHN A. DENT,
Associate Professor Mechanical Engineering,
University of Kansas.

Selecting a Prime Mover for the Industrial Plant

On page 242 of the Feb. 16 issue is a description of the power equipment recently installed in an industrial plant, and this article deserves close study by all engineers connected with an industrial plant. The following comments must not be interpreted to mean that the design of generating units is not ideal for that particular plant, but a few facts were gleaned from a study of the load condition and from the charts giving the relative quantities of steam used for heating and power, and one or two points not apparent at first glance can be considered to have an important bearing on industrial plant design.

For instance, at a load of 2,000 kw. and no steam bled, the water rate in 15.1 lb. at 2,000-kw. load, and bleeding 36,400 lb. of steam per hour the steam flow is 50,800 lb. Now, each 15.1 lb. of steam expanding all the way through the turbine develops a kilowatt-hour and with a steam flow of 50,800 lb. only 14,400 lb. goes to the condenser, this 14,400 lb. generating 953 kw. and the remainder of 1,047 kw. is generated by expanding 36,400 lb. of steam from 200 lb. and 100 deg. superheat down to 7½ lb. back pressure, giving a water rate of 34 lb. per kilowatt-hour for the high-pressure stages, considering them as a separate non-condensing machine. By the same process, the water rate of the high-pressure turbine at 1,500-kw. load and maximum quantity of steam bled is found to be 35.8 lb. per kilowatt-hour. At 1,000-kw. load the water rate of the high-pressure end is 39.76 lb. per kilowatt-hour when bleeding the maximum quantity of steam. These figures average 36.5 lb. of steam per kilowatt-hour for steam expanded to 7½ lb. gage pressure.

The energy available per pound of steam expanded from 200 lb. gage 100 deg. superheat to 7½ lb. back pressure is 182 B.t.u. and the high-pressure stages of the turbine show a Rankine cycle efficiency ratio of only 51 per cent. Since there are non-condensing engines that have attained an efficiency as high as 85 per cent at back pressures around 5 lb. to 20 lb. and could show 80 per cent in every-day operation, let us consider the effect on operating costs if a more efficient non-condensing power unit were installed. The steam flow chart gives the monthly flow for the year round for heating and process, which averages 16,000,000 lb. of steam a month. Allowing 15 per cent for Sundays and holidays when the engines are not in operation, the hourly steam flow for heating and process is around 22,666 lb. per hour, assuming the plant to run 24 hours a day, 25 days a month. The article states that the process and heating steam is supplied by steam bled from the main unit and the exhaust of the auxiliaries, which are turbine driven. No mention is made of using the air compressor exhaust—in fact, it is definitely stated that that unit is run condensing. At 36.5 lb. per kilowatt-hour for the high-pressure stages less than 620 kw. is derived from the average process steam flow. Making proper allowance for the fact that the auxiliaries use at least 55 lb. of steam per kilowatt-hour, the actual power output from the process steam is probably not over 520 kw. With motor-driven auxiliaries, the figure could be raised to 620 kw., but again I say that I am not claiming that this particular plant should be changed in any way, as my figures are general. But if a unit were installed in a plant having a process steam flow averaging 22,666 lb. per hour, at 75 per cent Rankine cycle efficiency ratio the power output would be 906 kw. with auxiliaries motor driven. This would reduce the load on the condensing unit by 386 kw. and would save 386×15.9 or 6,137 lb. of steam per hour, the figure 15.9 being the average water rate of the straight condensing turbine at loads from 1,000 to 2,000 kw. With 24-hour operation, evaporation of 10 lb. of water per pound of coal and $6 coal, the yearly saving would appear to be $13,237. But, as the steam flow chart shows, there is a wide fluctuation in demand at different seasons of the year, such as 30,000,000 lb. of steam for the month of December and about 8,500,000 lb. for June, July and August, making the hourly process steam load 14,000 lb. in summer and about 40,000 lb. in winter, which would tend to reduce the net saving.

A large paper mill solved the problem of getting the most power from its process steam flow by using a two-cylinder uniflow engine, one cylinder running condensing and the other at several pounds back pressure. The non-condensing cylinder always carried as much load as was necessary to keep up the required back pressure in the main header and the remainder was automatically carried by the condensing cylinder. The average water rate was 21 lb. per kilowatt-hour.

If this type of generating unit were used in the plant under discussion, the average power output of the back-pressure engine would be 22,666 divided by 21, or 1,079 kw.-hr. Apparently this would reduce operating costs by about $18,000 a year, but the higher capital charges might serve to reduce this saving by one-half, and there may be reasons why this plan could not be carried out in the plant referred to.

ANDREW F. SHEEHAN.
Brightwood, Mass.

The Flush Front for Tubular Boilers

In the Dec. 15, 1925, issue W. H. Wakeman says that he prefers flush-front boilers to extended fronts, because extended fronts are "head bumpers." In the West, where the coals are high in volatile, the objectionable smoke-box extension should be higher than 6 ft. from the floor, so that particular objection would be removed and Mr. Scheiderer's ideas as given in the Oct. 27 issue would be sound.

L. S. SHAW.
Cleveland, Ohio.

Questions and Answers

Order of Opening and Closing Boiler Blowoff Valves

In what order should the two valves, or valve and cock, on a boiler blowoff line be operated? Why?

On the assumption that there are two valves between the boiler and the main blowoff line, and that all parts are of relatively equal strength throughout the whole system, then it will make little difference as to which valve is opened and closed first, when blowing down. But if a valve and a plug cock is used, the valve is usually placed near the boiler, and the cock near the main blowoff line, then it would be better to operate like this:

To blow down, just open the cock, then slowly open the valve. When through blowing down, close the valve first, and then close the cock.

The flow and inertia of the water can be controlled better with the valve than with the cock, for if care is not taken, the cock could be opened or closed so suddenly and quickly that damage might result.

Sweating of Boiler Flue Sheet

In a sawmill as soon as the damper is closed on the boiler it begins to sweat at both the flue sheet and the front end. The sweating is so bad that in the morning water is usually found dripping out of the smoke box. This happens regardless of whether the boiler is fired with coal, dry wood or green wood, but I think a little worse on green wood. Will you advise how to overcome this?

It would seem from the description that instead of the boiler sweating it is in reality leaking. The leakage may be only very slight, and noticeable only when the damper is closed and the boiler not in service. When the boiler is in operation and the damper is open, the slight leakage may be quickly evaporated and carried off by the draft, and so it is not readily noticed. When the damper is shut and the draft stopped, the moisture persists and becomes noticeable. Look again closely for possible leakage at places where it could occur. Sweating might occur with a cold boiler, but not with one under steam.

Power Required to Operate Electric Elevators

How much power should be required to operate an electric elevator under average conditions?

One of the difficulties in answering this question is that there are no average conditions in elevator operation. The power used by an electric elevator motor will be influenced by the size and type of machine and the condition in which it is maintained, the type of controller, number of stops per car mile, the ability of the operator to make good landings with a minimum of inching, the design of the motor, the relation between the weight of the car and its average load and the weight of the counterweights, etc.

In passenger service with cars making about 200 stops per car mile, and the motor controlled by rheostatic control, about 8 kw.-hr. per car mile would be considered good practice. Under the same conditions with variable-voltage control the power consumption will be about 6 kw.-hr. per car mile. In the latter, the figures are for cases where the elevator is kept in operation. On account of the motor-generator-set losses, if the elevator is allowed to stand idle for a considerable part of the time with the motor-generator running, the power consumption per car mile may be much higher than 6 kw.-hr. With variable-voltage control and the car making 400 stops per car mile, such as would be the condition in a department store, the power consumption will be about 8 kw.-hr. per car mile. On express elevator service making 100 stops per car mile and using variable-voltage control, 4.5 to 5 kw.-hr. per cent have been obtained.

An operator that has to make two in three trials at landing the car level with the floor at each stop, can easily increase the power consumption 50 per cent over that required by a skilled operator. Another illustration of how the power consumption of an elevator is influenced is that found when changing from an old-type alternating-current motor not suited for elevator service to a modern motor designed for the work. In making these changes, power savings as high as 50 per cent have been obtained.

Resistance of Generator-Field Rheostat

Explain how the voltage from button to button on a field rheostat is computed when the resistance between any two buttons is known and the name-plate data are available. For instance, a rheostat name-plate reads 173 ohms, 20-3 amperes, 600 volts.

There is no way of calculating the voltage between the contact buttons on a rheostat when only the name-plate data are available. The rheostat could be connected in a circuit with another resistance to maintain the current within a safe value for the rheostat, and then, with a voltmeter, the voltage between each pair of buttons for this particular condition can be measured. The voltage between any pair of buttons divided by the current in amperes equals the resistance between the two contact buttons to which the meter is connected.

Where a rheostat is designed for a particular generator, the resistance between the adjacent contact buttons is made of such a value that the generator's voltage will increase or decrease in equal increment as the resistance is cut out or into the field circuit. To calculate this resistance a saturation curve of the generator, obtained by plotting the field-current against the generator's terminal voltage, must be available. Assume a generator that is to have a voltage range of 250 down to 200 volts. If the saturation curve showed that at 200 volts the field current was 5 amp., then the total resistance of the field circuit would be $200 \div 5 = 40$ ohms, which includes the resistance of the field winding. The field coil resistance is equal to the

maximum voltage of the generator divided by the maximum field current, and is obtained when the field rheostat is cut out of circuit entirely.

If the maximum voltage is 250 and the current is 10 amp., then the field-coil resistance is 250 ÷ 10 = 25 ohms, and the rheostat would have a total resistance of 40 — 25 = 15 ohms. If there are to be 25 divisions to the rheostat, each division will have a resistance that will cause a change of 50 ÷ 25 = 2 volts. Assume that on the saturation curve it is found that to cause an increase in generator volts from 200 to 202 it requires an increase in field current from 5 to 5.25 amp., then the total resistance of the circuit is 202 ÷ 5.25 = 38.48 ohms. This gives a decrease of resistance of 40 — 38.48 = 1.52 ohms, which is the value of resistance to be included between the first and second points of the field rheostat. The next point of resistance would be obtained by taking the current to produce 204 volts off the curve and dividing the latter by the former. This process is continued until the resistance for each point is calculated.

Distributing Load Between Turbo-Generators

What conditions govern the distribution of load among several turbo-generators feeding the same bus?

When a group of steam turbines drive alternating-current generators synchronized to a common bus, the speed of all the machines must be the same (unless the generators have differing numbers of poles—for example, a four-pole, 60-cycle generator will make 1,800 r.p.m., whereas a six-pole will make 1,200 r.p.m., and under such conditions, the speed of the entire system varies with the load. When the speed departs far from standard—that is, when the alternating-current frequency is too far from 60, an operator adjusts the governor of one or more turbines to take more steam and thus take a larger share of the load. Conditions become complicated when turbines of various capacities having governors with unequal ranges and operating speeds are tied together by an extended transmission network. A change in load may cause a turbine having a slow governor to overload or fully unload itself, or may set up electrical surges for which special protection must be designed. Turbine governor characteristics are an important element in the operation of electrical systems.

Changing the Coil Pitch on a Direct-Current Motor's Armature

We have a 50-hp. direct-current 250-volt armature in the shop, having 35 slots, three coils per slot, each coil made up of two turns No. 9 wire. The winding pitch is 1 and 9. There are 105 bars in the commutator. I would like to know what would happen in service if the armature was wound with the same type of coils, but the winding pitch made 1 and 10?

Since the armature has 35 slots and the winding pitch is 1 and 9, it is assumed that the machine is a four-pole motor. This being the case, the present pitch is three-quarters of a slot less than full pitch. Winding the armature with a coil pitch of 1 and 10 would spread the coils one-quarter slot more than full pitch. On account of the slightly increased inductance in the coils, with the pitch of 1 and 10, there will be a tendency for the commutation not to be quite so good as when the pitch of the coils was 1 and 9. The motor will also tend to run at a slightly lower speed, due to the winding's being more effective in generating a counter-electromotive force with a pitch of 1 and 10 than with a pitch of 1 and 9. However, none of these factors should be serious enough to produce any appreciable effect in the operation of the motor.

Relative Capacities of Pipes

How many 2-in. pipes would it take to carry as much water as one 10-in. pipe? Is 25 correct?

With respect to the number of 2-in. pipes required to carry as much water as one 10-in. pipe, your calculation of 25 is the ordinary approximation. Reference to the tables of dimensions of wrought-iron pipe indicates that the internal diameters are not exactly 2 and 10 in., and that a more exact ratio of areas is about 24 to 1 rather than 25 to 1. Of course the element of skin friction is of great importance, so that under identical conditions of head and quantity considerably less water would flow through twenty-five 2-in. pipes than through a single 10-in. pipe. Reference to the flow chart given in Marks' Mechanical Engineers' Handbook, on page 273, indicates that a 10-in. pipe will discharge about 78 times as much water as a 2-in. pipe, provided both are operating with the same loss of head.

Oil in Feed Water

Why is oil in feed water objectionable? What are the limitations of a pure mineral oil as a steam cylinder lubricant?

Oil in feed water is objectionable at all times because of the possible priming which it may cause and because it is likely to coat the heating surfaces and cause burning of the tubes or plates. A straight mineral oil will separate from exhaust steam more readily than a compounded oil, hence it is used largely in marine engines where the exhaust steam must be used for boiler feed. A compounded oil, on the other hand, will atomize more readily than a straight mineral oil, and as good lubrication is dependent to some extent upon complete atomization, in order that the oil may carry to all parts to be lubricated, a compounded oil frequently works out to better advantage.

Dry and Wet Bottom Boilers

What is the difference between a dry bottom boiler and a wet bottom boiler?

The terms "dry bottom" and "wet bottom," as applied to boilers, generally relate to marine or locomotive types. In a "wet bottom" boiler there is a water space entirely surrounding the firebox—top, sides and bottom. In a "dry bottom" boiler the top and sides only are in contact with water. There is no water space at the bottom. The circulation is better in the wet bottom, as there are no "dead ends" to interfere.

Function of a Dry Pipe

What is a dry pipe in a boiler?

A dry pipe in a boiler is for the purpose of preventing water from going out into the main steam pipe. It is a closed end pipe, perforated with holes or slots to admit steam, but difficult for the entry of water. This pipe runs in a direction that is at right angles to the steam outlet in the shell and connected to the outlet by means of a nipple and T. Should a small quantity of water get into the pipe, it will drain back into the boiler through the openings for the purpose located at the bottom.

Oxygen-Rich Air Used to Burn Low-Grade Coal

The centrifugal cream separator utilizes the difference in density of milk and cream to separate the two, the effect of centrifugal force being like that of gravity, but many times stronger at the high speeds employed. Theoretically this method of separation is applicable to a mixture of any two fluids of different densities. Air is a mixture of nitrogen and oxygen. Although the densities of these two gases do not differ greatly, there is an appreciable difference, oxygen weighing 14 per cent more than nitrogen.

When applying a centrifugal device to any such mixture of gases, it is evident that the natural tendency of gases to mix by diffusion must work against complete separation. It is also clear that with such slight differences in density, about all that could be accomplished with air at possible speeds of rotation would be to produce air somewhat enriched with oxygen.

This has been proposed at various times for use in boilers, blast furnaces, etc. Discussing the matter in the March, 1926, issue of the *Power Engineer*, Prof. Henry Briggs speaks of "remarkable and promising large-scale boiler experiments now proceeding in Italy under the direction of my friend Edouard Mazza, civil engineer and professor emeritus of Turin University." Professor Briggs states that the plant is situated at the Negri Co.'s electric power station at Savona and is raising steam of 180-lb. pressure by burning an inferior British coal by means of oxygenated air.

Although the use of enriched air does not, of course, add to the number of heat units theoretically available, it is said to make combustion more complete and reduces the loss of heat in the waste gases. "On both the scientific and technical sides," says Professor Briggs, "the Mazza process of centrifuging air is of much interest. By passing air into the center of a rotary separating drum or turbine, provided with vanes and rotating at high speed, air with a higher oxygen content can be drawn off from a stationary casing surrounding the drum, whereas air with a reduced percentage of oxygen is discharged through the hollow shaft of the machine.

"In most of the instances in which the Mazza process has been applied a fair degree of enrichment of the air is found. In the present case it amounts to an increase in the oxygen percentage (by volume) of from 21 to about 24 per cent at a cost of 2 per cent of the power generated by the boiler. Professor Mazza tells me that he is making two other machines, each costing under £200, which are to be installed in connection with a coal-fired boiler generating 3,000 hp.,[1] and an oil-fired boiler generating 6,000 hp.[1] respectively."

In closing his article Professor Briggs mentions various installations that preceded it. He says: "The first of these was at Ougre, Belgium, where the late Doctor Peters built a small blast furnace and operated it for several years with enriched air. Just after the war Mazza installed plants in the United States, one of which yielded nearly 3,000 cu.ft. of slightly enriched air per minute for a power expenditure of 12 hp. A similar plant has been constructed to supply enriched air to a hospital for the treatment of lung diseases."

[1]That is, mechanical horsepower at the prime mover.

New Water Supply for Great Lakes

Project, Which Is Claimed Will Solve for All Time the Lake-Level Problem, Eliminate Need for Dredging and Produce Over 1,000,000 hp. —The Cost Estimated at $150,000,000 and the Annual Income from Power Alone to Exceed $15,000,000

MAINTAINING and increasing the present low levels of the Great Lakes by introducing a new supply of water from the north into Lake Superior is the ambitious plan proposed some months ago and on the evening of March 11 outlined to the Chicago Chapter of the Izaak Walton League of America by C. Lorne Campbell, Canadian engineer and railway builder, of Toronto. From personal observation and investigation made during several years' interest in the situation and the major part of several summer seasons spent in the Far North, Mr. Campbell formulated a plan that he believes will offer a permanent solution of the lake-level problem and in addition produce an annual income of more than $15,000,000 from water power alone.

An expenditure estimated to exceed $150,000,000 would provide more than 1,000,000 hp. at hydro-electric plants along the lakes and the St. Lawrence River, save large sums that must be spent for harbor and channel dredging, restore full cargo-carrying capacity of all vessels plying the Great Lakes, open up to navigation a country rich in minerals and timber and provide for Chicago an adequate drainage system. It was his estimate that the decline in lake levels from natural causes in the next ten years would necessitate an expenditure of at least $500,000,000 for dredging harbors of the Great Lakes so that shipping could continue.

The plan proposed by Mr. Campbell has primarily to do with the diversion of the waters of the watershed of the Albany River and its main tributary, the Ogoki, by the construction of two great dams, one on each of the two rivers, and to bring these stored waters southward through a canal cut through the height of land on the southern side of this watershed, to flow from there south into Lake Nipigon and on through Nipigon River into Lake Superior. The accompanying map pictures the general plan.

In first placing the plan before the public, Mr. Campbell had depicted the creation of a new Great Lake 15,000 square miles in area, but this he does not consider of vital necessity to the project of diverting these waters in itself, but rather as an after consideration should a great storage reservoir become desirable.

To complete the various parts of construction necessary to effect the diversion would require six years. Mr. Campbell was of the opinion that the full effect of the water would be felt in the Great Lakes within two or three years after construction was completed and would ultimately bring back the level of the lakes to their original normal. After this the excess water might be either stored in the great reservoir of the sixth lake, or be allowed to run down its original course to James Bay, as then would be deemed most advisable.

Within the confines of the governing heights of land, the interior was a great level basin of rock, muskeg, swamp, vast timber areas, innumerable lakes and streams constituting a great natural reservoir. The average yearly minimum flow of the waters to be diverted was placed at 20,000 cu.ft. per second. At flood periods, which could be controlled, the flow would exceed 30,000 cu.ft. per second. The work necessary to carry out the project would be:

1. A railway approximately 125 miles long, over which would be transported machinery and supplies necessary to construct the dams and cutting.
2. Main cutting through the southern height of land—the deep part of which would be four to five miles long and from 190 to 200 ft. deep, with perhaps approaches of shallow depth.
3. The Ogoki dam, figured at 7,000 to 8,000 ft. in length and 130 ft. high at the highest point.
4. The Albany dam, which will be in the neighborhood of 9,000 ft. long and 145 ft. high at the highest point.
5. The deepening and straightening of a channel from the main cut south through the chain of small lakes and a river into Lake Nipigon.
6. The construction of the embankments previously mentioned along the eastern border of the height of land.
7. The installation of machinery at various points where increased hydro-electric power would be created by this additional water.

According to Mr. Campbell's estimate, the aggregate cost of these various works should be in the neighborhood of $150,000,000. The interest and sinking fund cost for this amount would approximate 11 to 12 millions per year.

On the credit side, Mr. Campbell stated that the project offered, first of all, a permanently restored Great Lakes water level. Secondly, it meant an increased hydro-electric capacity in excess of 200,000 hp. on the Nipigon River, more than 50,000 hp. at Sault Ste. Marie and more than 350,000 hp. at Niagara. It will be seen that at the points where hydro-electric plants already exist the total increased capacity from this added water would be approximately 600,000 hp., which at ½c. per kilowatt-hour would bring in a revenue of $15,000,000 per year. On the St. Lawrence River, where to date there are no complete developments, there would be eventually considerably

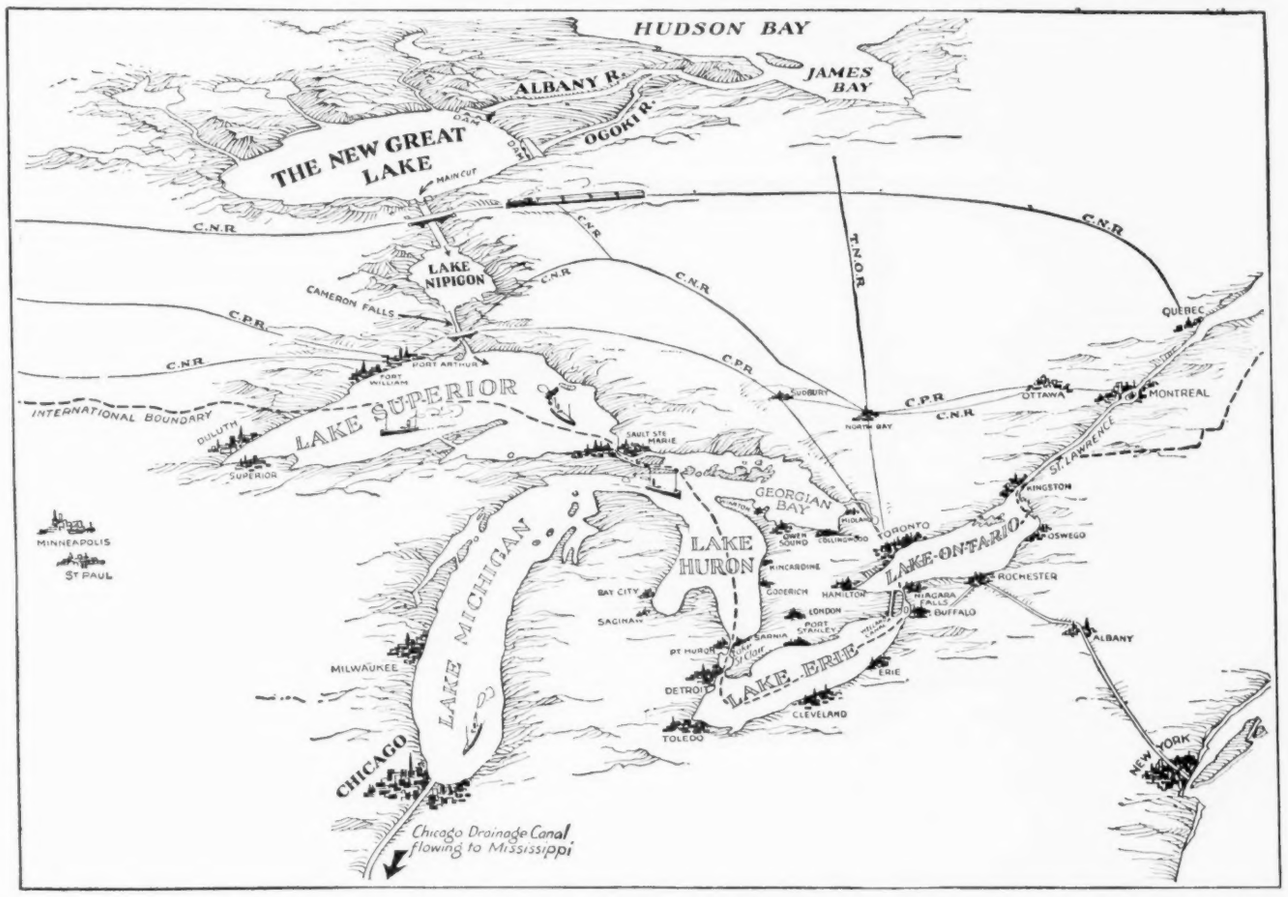
more revenue from the power projects.

As a third factor, this added water would eliminate the dredging program now facing all the cities and towns along the shores of the Great Lakes, which, in his opinion, would amount to much more than the entire estimated cost of the solution suggested.

Although the foregoing plans were based principally on estimates and a thorough knowledge of the country, Mr. Campbell was positive that accurate surveys would establish his contentions. The various remedial works along the Great Lakes chain that had been proposed in other plans to hold back and regulate the water in its flow would no doubt be beneficial to the situation, but they would not place any extra water in the lakes, and that was the prime necessity to cure permanently the conditions existing.

Engineers in attendance at the meeting applauded the magnificent scale of the plan, but for lack of accurate engineering data withheld judgment, especially in view of an article on the subject appearing in the *Engineering News-Record* of March 4, which, while confirming some of Mr. Campbell's contentions, gave much lower figures for watershed areas and the flow of water that might be diverted.

In response to a request made by Mr. Campbell that a committee be appointed to go into the details and investigate the project, the organization sponsoring the meeting responded by selecting as a committee of three, James O. Heyworth, a prominent engineer and contractor of the city and president of the Chicago Chapter of the League; George E. Scott, first vice-president of the American Steel Foundries, and Theodore W. Robinson, vice-president of the Illinois Steel Co.



Shows location of the proposed new Great Lake and its relation to the present Great Lakes system and St. Lawrence River

Extraction Turbines in Paper Mill Return 45 per Cent on Investment

By using extraction-type steam turbines for generating power and bleeding steam for paper drying, the Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich., saves a minimum of $12,804.48 and a maximum of $70,536.96 per year over other methods, according to a recent analysis. Three paper plants are operated, all the power for which is generated at two of the plants. Steam is generated in Wickes vertical boilers, and electricity is produced at 480 volts by **1,200-kw.** G. E. turbo-generators.

In the No. 1 mill variable speed engines are used to drive the paper machines, one rated at 200 hp. and the other at 300 hp. All the exhaust steam from the engines is used for drying. The electrical load of the mill is carried by a 1,250-kw. turbine generator, and 11,000 lb. per hr. of steam is extracted at 5 lb. per sq.in. for drying paper.

In the No. 2 mill, however, the paper machines have sectional motor drive. The electrical load of the mill, including the paper machine motors, is carried by two 1,250-kw. turbo-generators, and 22,000 lb. per hr. of process steam, sufficient to cover the drying requirements of the mill, is extracted at 5-lb. per sq.in.

By this method the turbines, in addition to driving their generators, are bled at the first stage at a rate of 22,000 lb. per hour, thus obtaining as a byproduct from the extracted drying steam and at practically no expense approximately 1,630 kw. of electric power. If the paper machines in the No. 2 mill were driven by variable speed engines, as in the No. 1 mill, 500 hp. would be required at not less than 35 lb. of steam per horsepower-hour. This would give, for drying purposes, but 17,500 lb. of steam per hour, whereas 22,000 lb. are required, costing $6.29 per hour. An additional 1,500 kw. of electrical power would be needed which, if furnished by a straight condensing turbine requiring 13.5 lb. of steam per hour, would cost $5.79 per hour, making a total cost of $12.08 per hour. If the additional 1,500 kw. were purchased, it would cost the paper company $13.50 per hour, at a rate of $0.009 per kilowatt-hour, making a total cost in that case of $19.79 per hour.

The present method, requiring 2,500 kw., costs $10.37 per hour. Thus there is effected a minimum saving of $1.71 per hour, or $12,804.48 per year, and a maximum saving of $9.42 per hour, or $70,536.96 per year. With the minimum saving, the paper company is paid a return of 45.8 per cent on its turbine and generator investment of $28,000.

News in the Field of Power

Bids on Muscle Shoals Invited by Joint Congressional Committee

Senators Deneen, Sackett, Heflin and Representatives Morin, James and Quin Members of Committee—Ford May Make Offer

EVERY effort is to be made by the Joint Congressional Committee on Muscle Shoals to wind up its work much earlier than April 26, the date it is required to report to the Senate. For that reason the committee is anxious that prospective bidders should submit their offers at the earliest possible date. In view of the great amount of publicity which has been given the matter of disposing of the government's properties, the committee feels that all interested are familiar with the status of the situation and can submit their bids without delay.

Following the acceptance by the Senate of the House amendments to the concurrent resolution establishing the Joint Committee, the Vice-president named Senator Deneen, of Illinois, Senator Sackett, of Kentucky, and Senator Heflin, of Alabama, as the Senate members of the committee. The Speaker of the House named Representative Morin, of Pennsylvania, Representative James, of Michigan, and Representative Quin, of Mississippi. Senator Deneen was elected chairman of the committee and Representative James vice-chairman. W. E. Murray, who served as clerk of the McKenzie Muscle Shoals Commission, was chosen as secretary of the Joint Committee.

The Joint Committee held a meeting on March 17 at which time Dr. R. O. E. Davis and Dr. William H. Ross, of the Department of Agriculture, appeared. Dr. F. G. Cottrell, Director of the Fixed Nitrogen Research Laboratory, appeared before the committee March 18.

Bids Invited on All or Any Part

The Joint Committee on Muscle Shoals invites all interested individuals, firms, or corporations to forthwith prepare and submit bids for all or any part of the government property at Muscle Shoals. In view of the short time given the committee in which to file its report, and of the time required for the negotiation of the terms and the preparing of a lease and drafting of appropriate legislation after the selection of the bid which the committee may favor for submission to the Congress, the committee requests that any and all bids be submitted at the earliest possible moment and be addressed to the Secretary of the Joint Committee on Muscle Shoals at the Capitol, Washington, D. C.

Mr. Henry Ford in passing through Montgomery, Ala., is quoted in the daily press of the South as having said in an interview, after having expressed his pleasure that Congress should authorize a joint committee to negotiate a lease for the Muscle Shoals property, that, "It is my intention to prepare and submit a bid to the committee." This statement has not been further confirmed or denied as this is written.

New York Cities Enforcing Anti-Smoke Ordinances

The New York City Health Commissioner announced that beginning with March 17 his department would strictly enforce the city ordinance prohibiting dense smoke resulting from the use of soft coal. He said "We had been forced to announce this resumption of a strict enforcement of the anti-smoke ordinance because of the extensive prevalence of ailments of the respiratory organs and other diseases caused or aggravated by the soft-coal smoke."

Mount Vernon and Yonkers are also planning a strict enforcement of their ordinances prohibiting the dense soft-coal smoke.

Lignite Powdered Fuel Tests Reported Successful

That successful tests are being made by the Missouri Pacific in using lignite for fuel in one of its large engines on the International-Great-Northern, is reported from Palestine, Texas. The lignite is used in powdered form and the new method is proving so satisfactory that this form of fuel will probably be adopted for all the engines on the International-Great-Northern, or at least on the divisions which are convenient to the lignite mines.

The Missouri Pacific engine which is used for the purpose of making the tests makes daily trips over the Palestine division and it has been pulling the longest trains ever handled by the road. It has pulled as high as 96 cars with a total of 5,000,000 lb. loaded weight. The engine is equipped with a "Dupont Simplex" standard stoker. This apparatus works on the principle of an oil mill cottonseed conveyor. The lignite used is ordinary mine run. The stoker carries the lignite to the firebox entrance, where it is injected into the firebox under heavy steam pressure.

It is said that the experiment with lignite is proving an unqualified success. It is stated that lignite is much cheaper than either coal or oil.

North Carolina Communities May Build Superpower Plant

There is a movement among several managers of municipal light plants in eastern North Carolina to form a district, such as the water district in Boston, and construct a superpower plant. The entire district would issue the bonds and the towns pay a set price per kilowatt-hour for the electric energy.

The Great Lakes to Atlantic Routes Report Due Soon

Decisive developments in Lakes-to-Hudson waterways project are in prospect. Proponents and opponents of the ship canal across the state of New York have been heard by the Board of Engineers for Rivers and Harbors, which has before it a strongly adverse report of the engineer commission created by special statute. The Board of Engineers is expected to lay its findings before the Chief of Engineers so that the latter official can report his findings to Congress not later than March 24.

Representative Dempsey, of New York, has requested that the finding be made available by that date so that the Rivers and Harbors Committee, of which he is chairman, may act on the project in time to include it in the legislative River and Harbor bill which will be reported out soon after April 1.

Those advocating the so-called all-American route contend that the commission has over estimated the cost and has underestimated the benefits. In addition, they are placing great stress on the value of such a waterway in connection with the national defense.

One of the important developments growing out of the filing of the report was the letter written by Secretary of War Davis to Representative Dempsey, of New York. In that letter Secretary Davis said that, "from the military standpoint it is essential that waterways connecting the Great Lakes with the Atlantic seaboard shall be entirely in American territory." He made the point that "in the event of a great war the transportation of the agricultural products and raw materials of the Middle West to the Atlantic seaboard and to the thickly populated industrial areas of the Eastern and New England states, would impose a great burden on the railroads. The probably resulting congestion could be relieved by the further development of the waterways connecting the Great Lakes and the Hudson River.

The report of the engineers on the barge canal route is expected to add materially to the support for the St. Lawrence project where the tangible benefits, largely because of the power resources of the stream, exceed the estimates of cost.

Anthracite Coal Corporation Urged by Senator Wheeler

In introducing a bill to create a Federal Anthracite Corporation to take over coal mines and operate them during times of emergency, Senator Wheeler, of Montana, made the following statement:

Coal is a necessity. Coal properties, although privately owned, must be held and operated subject to the paramount public interest. The distribution of coal is a part of the movement of interstate commerce and is necessary to the movement of interstate commerce. Coal provides one-third of the tonnage moved by the railways, (about 400,000,000 tons) and the railways consume over 120,000,000 tons annually. When mismanagement, selfish private interests, and industrial welfare periodically stop the production of coal and prevent the use of this national resource, which should be held in trust of the people, Congress should enforce this trust by exercising its power to regulate interstate commerce and to promote the general welfare.

Three means of exercising public authority are appropriate:

First, there should be a permanent bureau of information gathering and analyzing statistics of coal production and distribution, in order that when public intervention is necessary, public officials may be adequately informed.

Second, there should be provision for government aid and co-operation in the settlement of labor disputes, encouraging self-government in industry, but providing a machinery for government mediation and for voluntary arbitration of unsettled controversies which menace the general welfare.

Third, a law should be passed authorizing the Federal Government in an emergency to take over the mines, paying just compensation to the owners and just wages to the workers and operating the mines for public use instead of for private profit.

Therefore, I am introducing a bill to authorize the creation in a national emergency of a Federal Anthracite Corporation to take over coal properties and to operate them. The directors of this corporation are to be appointed by the President, representing in a measure the consumers and workers, but primarily the public as the owner and beneficiary of the properties.

Sudan May Have Power Development

Lake Tsana in Abyssinia is a potential source of water power which may soon be exploited for irrigation in the Sudan, according to the *New York Sun*. Its service would be in addition to that rendered by the Sennar dam. It is the source of the Blue Nile, has an elevation of 5.690 ft. above sea level and covers an area of 1,100 square miles. It is fed by three large rivers and its outlet is formed by three channels with an abrupt fall in a succession of rapids which later unite to form the Blue Nile. A few miles further on the river passes through a deep gorge only 20 ft. wide and its waters pitch over a cliff 150 ft. high. The average volume of water received annually by the lake is 6,572,000,000 cubic meters.

The value of this source of water and power was realized by Emperor Menelik, who sent an expedition to the basin in 1902 to obtain particulars of the volume available. In 1920 the Egyptian Ministry of Public Works sent another mission, headed by G. W. Grabham, the Sudan geologist. He recommended removal of part of the rocky bed at the outlet to enable the water to be run off to a depth of 18 ft. below the ordinary flood level and the increase of the reserve storage to 8,000,000,000 cubic meters, enough to meet deficits in two successive years of drought.

An effective capacity of 11,500,000,000 cubic meters is the estimated maximum of the reservoir. The cost of the necessary works is put at $11,000,000. The Abyssinian Government's permission would be necessary to begin work. It would be of immense benefit to the trade of the country in the employment of labor and the consequent large sums to be spent. In connection with the Sennar dam it would provide a potential source of never failing power and make the Sudan one of the most fertile regions in Africa.

Lakeside Low-Temperature Distillation Plant Ready

The low-temperature-distillation coal-treatment plant which is being installed at the Lakeside power plant of the Milwaukee Electric Railway & Light Co., which was mentioned in our annual review of the power industry, Jan. 5 issue, is reported as being near completion and it is expected that it will be put into operation within a month. This process is known as the McEwen-Runge method of low-temperature distillation.

Czechoslovakia May Have Many New Power Plants

The Ministry of Agriculture of Czechoslovakia is now drafting a proposed law, which will be presented to Parliament, authorizing the state to assist in the establishment of electric power plants in about 250 towns which have applied for such aid. On the basis of this law, the state, for a period of five years, would grant 6,000,000 crowns (about $174,000) for assistance in the establishment of these power plants.—*Commerce Reports.*

Valuation Engineers Needed in Income Tax Unit

The United States Civil Service Commission has announced an open non-assembled competitive examination for valuation engineer at $3,800 and associate valuation engineer at $3,000 to fill vacancies on the technical staff of the Income Tax unit of the Bureau of Internal Revenue. Applications will be received until April 20. Registers of eligibles in oil and gas, coal, hydraulic and hydro-electric as well as other subjects will be established. Information can be obtained from the Commission at Washington, D. C., or board of examiners at the post office or custom house in any city.

N. Y. City Considers Bill on Licensing Engineers

A bill, sponsored by Alderman Samuel Burden of Flushing, L. I., was presented to the New York City Board of Aldermen recently. It provides that a regular licensed steam engineer be employed to supervise heating plants in all apartment houses, office buildings, hotels and department stores wherein boilers of more than ten-pounds pressure are used or the fire box has an area of more than 240 square inches. Protests have been made by the representatives of hotel proprietors, building managers, steamfitters and plumbers.

Federal Encroachment on State Power Rights Cited

According to a statement by Governor Smith of New York in advocating a state water-power authority, published in the daily press, he questions the authority of the Federal Power Commission in regard to water powers within the state of New York:

Over and above every other consideration, the state should own these power plants in order to prevent the federal government from encroaching upon the domain of the state. That the federal government has already encroached there can be no doubt. The Federal Water Power Act, to my way of thinking, is an open infringement upon our own water rights. At a recent hearing before the State Water Power Commission it was brought out that the federal government had granted a permit to a power company to divert water from the Niagara River. We will concede the right of the federal government to have something to say about the diversion of water because of its control over navigation, but in this instance the federal government went a step farther and actually put a provision in the lease that the power plants and works were to revert back to the federal government at the end of fifty years.

What business has the federal government to make any such regulation or condition? When it did so, it encroached upon the domain of the State of New York. I am informed that under this permit this company does not propose to operate but desires to hold the permit in order to prevent anybody else from operating, thereby continuing the monopoly now enjoyed by the Niagara Falls Power Co. on the Niagara frontier.

Another encroachment upon the state's right can be found in the treaty between the Dominion of Canada and the United States providing for joint development on the St. Lawrence River. No one will deny the right of the federal government to make a treaty with the Dominion of Canada for the purpose of promoting navigation, but this treaty also provides for water-power development, and the United States has assumed its right of control over water power on the American side as clearly as it has assumed its right over navigation.

Production, Imports, Stocks, Exports and Domestic Consumption of Refined Gas and Fuel Oil and Lubricating Oil for January, 1926

	Barrels of 42 Gallons					
	Gas and Fuel Oil			Lubricating Oil		
	Dec., 1925	Jan., 1926	Jan., 1925	Dec., 1925	Jan., 1926	Jan., 1925
Production	30,906,000	29,319,000	27,891,000	2,711,000	2,649,000	2,456,000
Daily average	996,968	945,774	899,710	87,452	85,452	79,226
Imports	417,000	863,000	1,053,000	1,000	2,000	1,000
Daily average	13,452	27,839	33,968	32	64	32
Stocks:						
End of month	*24,681,000	*23,266,000	*18,425,000	7,267,000	7,544,000	6,670,000
Increase during month	*†2,585,000	*†1,415,000	*†1,131,000	269,000	277,000	250,000
Daily average	*† 83,387	*† 45,645	*† 36,484	8,677	8,935	8,065
Exports	3,482,000	3,612,000	2,454,000	947,000	720,000	946,000
Daily average	112,323	116,516	79,161	30,548	23,226	30,516
Indicated domestic consumption	.....	.....	.....	1,496,000	1,654,000	1,261,000
Daily average	.....	.....	.....	48,259	53,355	40,677

*East of California. †Denotes decrease. Owing to change in method of reporting to the Government bureau, the stocks of gas and fuel and heavy crude oil are combined in the figures for California (Pacific Coast territory), thus making it impossible to obtain figures showing indicated consumption of crude oil and refined gas and fuel oil for the country as a whole—American Petroleum Institute.

Philadelphia's Water Supply Failure Investigated by Ledoux

Shawmont and Torresdale Plants in Bad Condition—Mayor Kendrick Dismisses Operating Engineers Kerr and McGowan

A THREE-DAY drought in the northwest section of Philadelphia recently was the cause of a heated discussion in that city which led to an investigation of the pumping plants of the water-supply of the city by John W. Ledoux, a hydraulic engineering expert who was appointed by Mayor Kendrick.

The Ledoux report is exhaustive and covers the Shawmont, Roxborough and the Torresdale plants. It also includes the primary causes of the recent breakdown and lists recommendations to prevent a recurrence of such a situation. The Shawmont and Torresdale plants were found to be in the worst condition as the equipment had been allowed to run down, provision having been made to use current from the Philadelphia Electric Co. to run the new electric pumps.

The report, summarized by Mr. Ledoux, as published in the *Public Ledger* in part is as follows:

Causes of Failure

First. Neglect to provide an adequate supply of anthracite coal for such an emergency as should have been foreseen when the strike was first agitated and the winter coming on, or

(1a) Neglect to train the force to use bituminous coal with Coxe stokers, or

(1b) Neglect to secure a supply of bituminous coal of satisfactory quality, or

(1c) Neglect to equip the firebox with flat grates for hand firing bituminous coal.

Second. Neglect to keep boilers in good condition.

Third. Neglect to furnish and continuously operate adequate means for softening the water.

Fourth. Neglect to provide ample standby capacity for the electrical generators in Shawmont statoin.

Fifth. Neglect to provide means for adequately maintaining at all times a satisfactory depth of water over the river intakes at Shawmont.

Sixth. No provision made for coagulating the water in the Lower Roxborough sedimentation basin.

Seventh. Neglect to provide facilities so that the Upper Roxborough booster pumps will operate with sufficient standby capacity for all conditions likely to be encountered.

There are a great many other shortcomings on this system, but those above are the most vital ones.

As to why the conditions were permitted to reach that stage, it is only a matter of speculation, but it is pretty safe to state that it was anticipated that the Shawmont station would be soon discontinued and that appropriations for keeping the plant in first-class condition were difficult to obtain.

The ash-handling facilities are also unsatisfactory, and the conditions in the gallery through which the cars have to be moved by hand are so bad that it is difficult to get men who will do that work continuously, due to the dust and gas in such a narrow pasageway. This will all be remedied with the electric pumps.

Recommendations Made

As all the pumping stations depend for their operation on fuel, a supply of same must be assured.

As the water comes from the Schuylkill and Delaware Rivers, the intakes must be kept in such condition that they cannot be rendered inoperative by storms or freshets.

As the boiler plants cannot operate satisfactorily with bad water, adequate means must be used and ready at all times for making the water perfectly fit for boiler use. This applies particularly to the Schuylkill, which is unusually hard on boilers.

All boilers should be frequently inspected and kept clean and ready for operation in any emergency.

Pumping units should be sufficient in capacity and ready for operation so that no matter what happens to any unit, there is sufficient reserve capacity to take care of the maximum supply.

The same applies to the auxiliaries, to the electric generators, to the low service and booster electric-driven stations.

Sedimentation basins should be maintained full and the filter plants kept constantly clean, the coagulating devices kept in working order, and the chlorine plants kept in as near perfect condition as possible.

Sufficient supplies for all these purposes should be kept constantly on hand.

The most resourceful and capable men should be in charge of the most important stations, and the wages and bonus systems should be so devised as to put an effective premium on constant attendance.

Even if a station is known to be discontinued in the near future, its equipment and efficiency should not be permitted to run down for a moment, and it should be kept as near 100 per cent condition as possible until the new system which replaces it is in successful operation.

Dredging Outfit Proposed

At Shawmont, a dredging outfit should be supplied to maintain the depth of water over the intakes.

Full equipment should be provided and used for keeping the boilers in good condition.

The steam turbine-driven pumps — Nos. 4, 5 and 6—should be put in condition for operation up to their rated capacity, and preferably, new pumps of higher efficiency should be furnished to replace these.

The 500 kw. generator should be immediately put on its foundation, ready for operation.

Install a suction well for use with the booster station motors to enable any one of the pumps to work under maximum head.

At Lower Roxborough sedimentation basin provides for coagulating the water as a preparation for filtration.

In this investigation I have had the assistance of many persons connected with the Water Bureau, and I take pleasure in stating that every one showed the utmost consideration and frankness and willingness to furnish any assistance and information in his power.

As the conditions at Shawmont and Torresdale were the most serious of any of the plants inspected, I have attached an appendix describing the boiler plants of these stations in some detail, and for that purpose have had the assistance of J. M. Whitham, an eminent mechanical engineer.

Mayor Kendrick Dismisses Operating Engineers

On March 13, Mayor Kendrick ordered the ouster of Robert Kerr, chief engineer at the Torresdale plant, and George McGowan, chief engineer at the Shawmont. Director of Public Works, Mr. Biles, after a conference with the Mayor gave out the following statement setting forth the reasons for these dismissals:

The chief engineers of the Shawmont and Torresdale pumping stations, were dismissed because they were found to be incompetent. Investigations carried on by experts, in and out of the city government, resulted in the unanimous decision that the Shawmont and Torresdale plants had been neglected, were badly in need of repair and that the rehabilitation, which was imperative, could not be brought about under the direction of the two men in charge up to last Saturday.

Accordingly, after careful study of the situation, temporary appointments were made to the positions of chief engineer of the two stations and, in an effort to maintain a complete check and supervision of the work of rehabilitation, Solomon M. Swaab, consulting engineer to the Mayor, and John M. Lukens, chief of the Bureau of Boiler Inspection, will have direct supervision of the two plants while they are being put in first-class condition.

Former Chief of the Water Bureau Mr. Dunlap declared in a published statement defending these engineers:

It is the rankest kind of injustice to single out these men and offer them up to the public as a sacrifice.

The public may not know that the chief engineers of the pumping stations are not responsible for the repairs to the machinery of their stations. This responsibility was taken from them some three or four years ago and under the present organization they are only operating engineers. The repairs are made by a force of mechanics controlled from City Hall or the shop at 29th and Cambria Streets, upon requisition from the chief engineer.

Demand has been made upon the City Council for the dismissal of Chief Murdoch, of the Water Bureau by W. W. Roper, councilman.

Councilman C. K. Crossan, who is particularly interested in sifting the reasons for the dismissal of the chief engineers of the Shawmont and Torresdale pumping stations, held a somewhat lengthy conference with Mayor Kendrick.

Upon leaving the Mayor's office he declared that he was convinced Mayor Kendrick would give a satisfactory explanation of the dismissal of the two engineers.

Proposals for contracts for furnishing and installing motor-driven pumps at the booster stations of the Shawmont and the Roxborough works were opened March 16 by Director Biles, of Public Works.

A second water famine threatened the northwest section of Philadelphia because of the bursting of a boiler valve at the Shawmont station on March 17. The valve burst as J. W. Ledoux conducted by Walter Diamond, temporarily appointed to succeed George McGowan as chief engineer, were inspecting the plant to see if the recommendation of the expert were being carried out.

Shortly after the boiler broke down, John M. Lukens, chief of the city's boiler inspection, took charge of the repair work. Clad in overalls he directed the employees of a construction company engaged to rehabilitate the boiler room.

Mechanical Stokers Sold During February

The Department of Commerce announces that during the month of February, 1926, there were sold 83 mechanical stokers which were installed under 12 fire-tube boilers of 20,650 sq.ft. of heating surface and 71 water-tube boilers of 310,760 sq.ft. of heating surface.

Crude Oil Production Decreases Slightly

The American Petroleum Institute estimates that the daily average gross crude oil production in the United States for the week ended March 6 was 1,920,300 bbl. as compared with 1,927,050 bbl. for the preceding week, a decrease of 6,750 bbl. The daily average production east of California was 1,321,300 bbl., as compared with 1,324,050 bbl., a decrease of 2,750 barrels.

Italy Continues Expansion of Power Resources

Data regarding the situation of the electrical industry at the end of 1925 has just been made public in Italy. The capacity of Italy's electric power plants which, at the outbreak of the war was 1,360,000 hp., has now reached 3,200,000 hp., as compared with 2,860,000 at the end of 1924 and 2,500,000 hp. at the end of 1923, according to the published data. In spite of this rapid increase in producing capacity, the consumption of power has grown even more rapidily and is now estimated at 7,600,000,000 kw-hr. or more than three times what it was in 1914, for which the figure was 2,400,000,000 kw.-hr. Furthermore, only a small portion of the current produced, approximately 8½ per cent is used for lighting, and the remainder serves for industrial purposes and traction. The comsumption is by no means evenly distributed throughout the country, for in the Southern provinces and the islands, electrical development is only beginning and while in the North per capita consumption ranges between 400 and 500, which is approximately equal to that of the United States; in the South the average is less than 50 kw.-hr. Nevertheless, since 1914 consumption has more than doubled, and the general average during the past ten years has gone up from 70 to 185 kw.hr. per capita.

There are more than 2,000 producing power plants in Italy of which about 400 are of major importance. Practically the entire production is derived from water power, since the steam plants which have a capacity of about 580,000 hp. only operate a few hundred hours during the year to help out during periods when there is a scarcity of water. Of the total, 7,600,000,000 kw.-hr. consumed in 1925, only about 300,000,000 were derived from steam. It is calculated in Italy that if all of the electric power consumed had been generated with coal, approximately 10,000,000 tons costing over $396,000,000 would have been required, which indicates the growing importance of the electrical industry in Italy's economic life. In order to reduce still further the need for subsidiary steam plants, more and more reservoirs and artificial lakes are being constructed, of which there are already about 100 with a capacity of over 860,000,000 cubic meters of water. In addition, 17 reservoirs with a capacity of 700,000,000 cubic meters are under construction as well as new power plants capable of producing 900,000,000 hp. which will be completed within three or four years.

The progress that Italy has made in electrification has required and will require a steady flow of new capital. Thus, during 1925, the investment of new capital in electrical companies amounted close to $347,400,000 and even when reduced to a gold basis in order to eliminate the apparent increase resulting from the depreciation of the currency, the total invested capital is now nearly five times that it was in 1914, according to a report to the Department of Commerce from Commercial Attache MacLean at Rome.

River Jordan Power Project Contract Signed

The Jerusalem correspondent of the *London Daily Express* says the negotiations for the Ruthenberg scheme to harness the River Jordan for the production of electric power and irrigation of the Jordan Valley have been concluded, and that the British High Commissioner, Lord Plumer, has signed a £2,000,000 concession.

Institution of Mechanical Engineers New Officers

William Reavell has been elected president of the Institution of Mechanical Engineers at London. He founded the firm of Reavell & Co., Ltd., Ipswich, manufacturers of air compressors, etc., in 1898. Prof. W. E. Dolby and Sir Henry Fowler have been elected vice-presidents.

The new members of the council are: H. I. Brackenbury, Prof. G. F. Charnock, Lieut-Col. E. Kitson Clark, Eng. Vice-Admiral R. B. Dixon, A. L. Evans, F. H. Livens and Sir E. Petter.

Regional A. S. M. E. Meeting Power Papers

The tentative program of the New England Regional meeting of the A.S.M.E., which is to be held at Providence, R. I., May 3-6, will have papers of interest to *Power* readers as follows:

"Industrial Boiler Efficiencies," by S. D. Fitzsimmons.

"Schemes for Supplying Power and Heat to Industrial Power Plants," by Marcus K. Bryan.

"Rotary Swaging," by J. H. Connelly.

"Comparative Performances of Air Preheaters," by N. E. Funk.

"Tests on Stoker Fired Boilers in Hell Gate Station, United Electric Light & Power Co.," by H. W. Leitch.

"New Boiler Equipment at I.R.T. Co.'s 50th Street Plant, New York City," by H. B. Reynolds, J. H. T. Haggart and R. S. Lane.

Largest Impulse Turbines To Be Installed in California

Orders have been placed by the Southern California Edison Co. for two 56,000-hp impulse turbines, one unit to be built in San Francisco by the Pelton Water Wheel Co. and the other by the Allis-Chalmers Manufacturing Co., Milwaukee. Both units are to be built for an effective head of 2,200 ft. and a speed of 250 r.p.m. for 50-cycle operation. Provision is to be made in both turbines for changing to 60-cycle operation, in which case the speed will be increased to 300 r.p.m. The static head is 2,420 ft.

This equipment will be the first to be installed in the new Big Creek No. 2A plant, the ultimate capacity of which is 300,000 hp. These wheels will exceed the present world's record for capacity by 16,000 hp., this record having been established by two Pelton Company 40,000-hp. impulse turbines installed in the Serra plant of the São Paulo Tramway, Light & Power Co., São Paulo, Brazil and the Balch development on the Kings River, owned by the San Joaquin Light & Power Co. where one 40,000-hp. double overhung Allis-Chalmers impulse turbine, to operate under 2,381 ft. head at 360 r.p.m. is installed.

Grand Falls Project Progressing

It is understood that the Grand Falls power development project on the St. John River in the province of New Brunswick is to be proceeded with very shortly. The formal agreement under which the development is to be carried out is now being prepared.

The Government of New Brunswick, the International Paper Co. and the Fraser companies are the three principal parties to the agreement. Premier Baxter recently stated that he was determined that the necessary legislation should be passed at the present session of the Legislature, so that the work may be immediately proceeded with. "The arrangement entered into," he said, "calls for the development of Grand Falls to be completed, so that power will be available before the end of next year." He added that the development would probably run into an expenditure of from $25,000,000 to $40,000,000.

Personal Mention

Arthur J. Slade, consulting engineer, is soon to be established in an office in Paris, France.

James H. Bell is now connected with the New York City office of the Wheeler Condenser & Engineering Co.

Charles D. Steffens has joined the engineering department of Griscom-Russell Co., in New York City.

L. G. Sims has been appointed lecturer in electrical engineering at the University of Birmingham, England.

Dr. Michael I. Pupin, president of the E.I.E.E., will deliver the charter-day address at the University of California on March 23.

H. I. Keen has been elected managing director of the newly incorporated Allis-Chalmers of France with headquarters at Paris.

Major Max Toltz of St. Paul, Minn., has given $15,000 to the A.S.M.E. to establish a fund for the assistance of students in engineering.

Francis B. Sands has left the Wheeler Condenser & Engineering Co. and is now connected with the New York City office of the Wilson-Snyder Mfg. Co.

George L. Bayer, formerly with the power plant division of the Milwaukee Electric Railway & Light Co., has joined the staff of V. D. Simmons, consulting engineer of Chicago.

Markham Cheever, chief engineer and general superintendent of the Utah Power & Light Co., has joined the staff of the Electric Bond & Share Co. of New York City.

Professor Th. DeDonder, of the University of Brussels, arrived on March 22 to give two series of lectures at the Massachusetts Institute of Technology. One series will be devoted to the mathematical theory of electricity and the other to relativity.

Dr. A. P. Coleman of the University of Toronto recently delivered an address to the Royal Canadian Institute on the subject of "The Earth as a Heat Engine."

Rudolph Ulrich, formerly of Louisville, Ky., is now located at Pittsburgh, Pa., where he holds the position of mechanical engineer with the Bacharach Industrial Instrument Co.

E. G. Schlayer, formerly with the Connecticut Co. at Hartford, as combustion engineer, has joined the organization of the Bernitz Furnace Appliance Co., 80 Federal St., Boston, Mass.

Daniel L. Bellinger has resigned from the D. J. Murray Manufacturing Co. of Wausau, Wis., to become president of the Mount Morris Valve Corp. a new company organized to take over the standard line of brass valves formerly made by the McNab & Harlin Manufacturing Co. of Paterson, N. J.

A. V. Hutchinson who for three years has had charge of the publications of the American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City, has been appointed as the new secretary of the society. Mr. Hutchinson will continue as manager of publications in addition to his new duties.

F. V. Magalhaes has been appointed general superintendent of distribution and installation for the Borough of Manhattan for the New York Edison Company. Mr. Magalhaes is secretary of the United States National Committee of the International Electrochemical Commission.

Dr. Oskar von Miller, pioneer in hydro-electric work and founder of the industrial museum in Munich, Germany, was made the recipient of the Grashof medal by the German Society of Engineers on the occasion of his seventieth birthday. The award is the highest order of merit conferred by the society.

Alford J. T. Taylor who has been located at Toronto, on March 1 assumed the duties of managing director of the Underfeed Stoker Co., with headquarters at Aldwych House, London, England. Mr. Taylor will at the same time continue as president of the Combustion Engineering Corp., Ltd., and as chairman of the board of the Ruths Steam Accumulator Co.

A. W. Berresford, for about twenty years vice-president and general manager of the Cutler-Hammer Mfg. Co., Milwaukee, Wis., was recently appointed executive vice-president of the Nizer Corp., Detroit, which not long ago was consolidated with the Kelvinator Corp. and the Grand Rapids Cabinet Co. operating as divisions of the Electrical Mfg. Company.

Obituary

Capt. J. W. Shea one of the original founders of the M.E.B.A. died after a long illness at the home of his daughter at Atlantic City, N. J., on March 3 at the age of 83. The death of Capt. Shea leaves only one living member of the original founders of the M.E.B.A. organization, William Kennedy of Cleveland.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., June 1-2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Providence, R. I., May 3-6. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

American Welding Society. M. M. Kelly, 29 West 39th St., New York City. Annual convention at 29 West 39th St., New York City, April 21-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Kansas State Association.** H. S. Dukes, School for the Blind, Kansas City, Mo. Convention at Abilene, Kans., May 19-21; **New England States Association.** Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association.** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Minnesota State Association.** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National Board of Boiler and Pressure Vessel Inspectors. C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio. National Board meeting at Chicago, Ill., May 3-5.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Power Show. International Textile Exposition—James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show will be Department "D" of the International Textile Exposition, and will be under the auspices of the New England Association of Commercial Engineers, and held at the Mechanics Bldg., Boston, Mass., April 12-17.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from May 31 to Dec. 1.

George Ed. Boler died at his home in Memphis, Tenn., on Feb. 9 at the age of seventy years. A native of Iowa, Mr. Boler was chief engineer on a number of famous Upper Missouri River boats in the early seventies, including the "Coahoma," "Peter Kerns," "Wyoming," "Joe Peters," "Ida Darragh," "Dean Adams" and others, during which time he made his home in St. Louis and Memphis. About 1900 Mr. Boler left the river and had charge of some of the power plants of Memphis' important industrial and public buildings. He belonged to the M.E.B.A. and the Steam and Operating Engineers' Union. He is survived by his widow.

Society Affairs

The Baltimore Section of the A.S.M.E. will hold a luncheon meeting at the Engineers' Club on March 24 at which J. R. Baylis, chemist of the Baltimore Water Supply Co., will speak on "Corrosion."

The Worcester Section of the A.S.M.E. will hold its March 26 dinner meeting at Sherer's restaurant. Stewart M. Marshall, consulting engineer of New York City, will speak on "Industrial Conditions in Russia."

The Metropolitan Section of the A.S.M.E. will hold a meeting at the Engineering Societies Bldg., 29 West 39th St., New York City on April 8 at which "Qualifying Engineers for High Executive Positions" will be considered.

The Cleveland Section of the A.S.M.E. will hold a joint meeting with the **S.I.E.** and **A.S.C.E.**, on March 23 at the Hotel Winton at 8 p.m. J. W. Ellms, engineer of the water supply and sewers department of the City of Cleveland will preside. The subject will be "Relation Between Quality of Water and Industrial Development in the United States," by W. D. Collins, chemist in charge of quality of water division, U. S. Geological Survey. Important discussions will follow the paper.

Business Notes

The "Flexitallic" Gasket Co., Camden, N. J., announces that it has opened an office in Chicago with E. H. Bolton in charge at the Madison Square Bldg., 123 West Madison St.

The Chicago Fuse Mfg. Co., Laflin & 15th Sts., Chicago, Ill., manufacturers of electrical protecting materials and conduit fittings, announces the appointment of L. F. Blendermann as district sales manager at Philadelphia.

The Chicago Pneumatic Tool Co., 6 East 44th St., New York City, announces its acquisition of the George Oldham & Sons Co. of Baltimore, riveters, effective Feb. 16. The manufacture of the Oldham products, which are to be continued, will be conducted at the Detroit plant at 6201 Second Blvd. The sales will be combined and handled from the Chicago Pneumatic Tool Co.'s branches now operating in the principal cities.

The McClave-Brooks Co., Scranton, Pa., announces the appointment of Everett H. Allison, formerly in the Chicago office, as district manager of its Cleveland territory with headquarters at 508 Leader-News Bldg., Cleveland, Ohio.

Trade Catalogs

Stokers — Combustion Engineering Corp., Broad St., New York City, "Green Forced Draft Stoker," Catalog GFD-1, describes this new stoker for free-burning bituminous or lignite coal. It is well illustrated and altogether an attractive catalog.

Isolating Vibrations — The Korfund Co., Inc., 11 Waverly Place, New York City. "How to Isolate Vibrations," is the name of a new bulletin issued by this company. Drawings of the arrangements of foundations, illustrations of installations as well as descriptions of the plates are given.

Pulverized Fuel Burning — Combustion Engineering Corp., Broad St., New York City. Catalog U-1 "G-E Unit System for Burning Pulverized Fuel," to serve boilers from 1,500 sq.ft. heating surface up, is well illustrated with drawings of the unit and photos of installations.

Meters, Water—Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill. Bulletin No. W-11, "Republic Water Meters," which has just been issued, gives concrete information in regard to the flow of water through pipes. The bulletin contains many illustrations showing the design and operation of the meter manufactured by this company.

Valves—Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa. Bulletin No. 8-K. covers bleeder-turbine protecting valves designed for use in the extraction lines leading to the feed water heaters operated in connection with many bleeder type turbines.

Recorders, CO_2—The Brown Instrument Co., Wayne and Windrim Aves., Philadelphia, Pa. "Approval Deserves Weight Coming from Those Who Know"—Horace Greeley, is the title of a catalog giving users opinions and descriptions of the CO_2 recorder built by this company.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Mar. 15 1926
Pool 1	New York	$2.00@$3.00
Smokeless	Boston	1.75
Clearfield	Boston	1.85@ 2.25
Somerset	Boston	1.90@ 2.40
Kanawha	Columbus	1.40@ 1.70
Hocking	Columbus	1.35@ 1.70
Pittsburgh	Pittsburgh	2 00
Pittsburgh gas slack	Pittsburgh	1.40@ 1.50
Franklin, Ill.	Chicago	2.35@ 2 50
Central, Ill.	Chicago	2.00@ 2 25

Bituminous Net Tons	Market Quoting	Mar. 15 1926
Ind. 4th Vein	Chicago	2 10@ 2.35
West Ky.	Louisville	1 25@ 1.50
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	2 50@ 3 50
Buckwheat No. 1.	Philadelphia	3.00@ 3.50
Birdseye	New York	2.00

FUEL OIL

New York—Mar. 18, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Mar. 9, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95 per bbl.; 26@28 deg., $2.00 per bbl.; 28@30 deg., $2.05 per bbl; 30@32 deg., $2.10 per bbl.; 32@36 deg., gas oil, 5.65c. per gal.; 38@40 deg., 6.2c. per gal.

Pittsburgh—Mar. 9, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Mar. 6, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Mar. 12, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati — Mar. 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Mar. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.25 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.50.

Boston—Mar. 9, tank car lots, f.o.b.; 12@14 deg. Baumé, 4⅞c. per gal.; 28@32, deg., 6c. per gal.

New Plant Construction

Ala., Anniston—L. B. Liles, et al, will receive bids until March 25 for the construction of a 10 story office building at 10th and Noble Sts. Estimated cost $500,000. Warren, Knight & Davis, Empire Bldg., Birmingham, are architects.

Ark., El Dorado—Exchange Realty Co., Exchange Bank Bldg., will receive bids about April 1 for the construction of a 10 story bank and office building at Washington and Oak Sts. Mann & Stern, 705 A. O. U. W. Bldg., Little Rock, are architects.

Ark., Little Rock—Fourche River Land Co., 213½ West Second St., plans boring deep wells, also the installation of an engine, pump, 25,000 gal. tank on tower, etc. Private plans. Work will be done by owner's forces.

Calif., Bakersfield—San Diego Ice & Cold Storage Co., San Diego, has acquired the Bakersfield Ice Co.'s plant and plans to remodel for cold storage warehouse.

Calif., Sacramento—C. S. Luce, P. O. Box 155, plans the irrigation of 230 acres, a centrifugal pump, 10 in., 8 cu.ft. capacity direct connected to an 18 hp. electric motor will be required.

Calif., San Andreas—Calaveras County, Bd. Supervisors, A. W. Poe, Clk., will receive bids until April 5 for the installation of a pump, 100,000 gal. tank, etc. for waterworks.

Calif., San Francisco—G. A. Applegarth, Claus Spreckels Bldg., Archt., is preparing plans for the construction of a 15 story hotel at Geary and Taylor Sts. Estimated cost $1,000,000. Owner's name withheld.

Calif., San Francisco—F. W. Leis, 105 Montgomery St., is having sketches made for the construction of a 12 story arcade office building at Market and Fulton Sts. Estimated cost $1,000,000. A. L. Worswick, 700 Octavia St., is architect.

Calif., San Francisco—Y. M. C. A. Leavenworth St. and Golden Gate Ave., is having plans prepared for the construction of a 16 story hotel at Turk and Leavenworth Sts. Estimated cost $800,000. F. H. Meyer, 742 Market St., is architect.

Calif., San Luis Obispo—San Luis Obispo County Waterworks Dist. No. 2, plans an election to vote $35,000 bonds for the construction of a distribution system including pumps, etc.

Calif., Saugus—E. R. Ruiz, Box 93, plans irrigation of approximately 75 acres including three 10 in. turbine pumps, total lift 60 ft., also 15 hp. gasoline engines, etc.

D. C., Washington—City Central Corp., 209 Washington St., Boston, Mass., awarded contract for the construction of a bank and office building here to Boyle Robertson Construction Co., 813 15th St. N. W. Estimated cost $2,000,000.

Fla., Fort Lauderdale — Chateau Park Corp., awarded contract for the construction of a 3 story hotel on Michigan Ave., to Charles F. McKenzie Co., 123 N. E. 3rd Ave. Estimated cost $500,000.

Fla., Fort Lauderdale—W. H. Marshall, had plans prepared for the construction of an 11 story hotel on Los Olas Blvd. Estimated cost $500,000. J. M. Peterman, 346½ Los Olas Bldg., is architect.

Fla., Jacksonville—Vanderbilt Hotel Corp., W. H. Marshall, Pres., New York, N. Y., will soon receive bids for the construction of hotel here. Estimated cost $2,000,000. Warren & Wetmore, 16 East 47th St., New York, N. Y., are architects. A. L. Hibbo, 10 East 47th St., New York, N. Y., is engineer.

Fla., Jacksonville — George Washington Hotel, 510½ Broad St., will soon award contract for the construction of a 12 story hotel. Marsh & Saxelbye, West Blvd., are architects.

Fla., St. Petersburg—Ninth Street Bank & Trust Co., J. N. Brown, Pres., is having plans prepared for the construction of a 15 story bank and office building. Estimated cost $1,000,000. M. L. Elliott, Hall Bldg., is architect.

Ill., Chicago—S. Cole & Associates, 307 North Michigan Ave., is having plans prepared for the construction of a 16 story hotel at Walton Place and North Dearborn St. Estimated cost $1,750,000. B. Leo Steif & Co., 307 North Michigan Ave., is architect.

Ill., Chicago—Flamingo Hotel Corp., c/o W. Reichert, 35 South Dearborn St., Archt., is having plans prepared for the construction of a 17 story apartment at South Lake Shore Drive and 55th St. Estimated cost $2,000,000.

Ill., Chicago—Niemann Table Co., 72nd St. and Maryland Ave., plans the construction of a factory and power plant at 95th St. and Cottage Grove Ave. Sessions Engineering Co., 208 South La Salle St., is engineer.

Ill., Chicago — K. Rosenthal, 77 West Washington St., is having plans prepared for the construction of a 14 story apartment at Chestnut and Ernst Court. Estimated cost $1,225,000. Olsen & Urbain, 155 North Clark St., are architects.

Ill., Chicago—Syndicate, c/o E. J. Meles, 165 West Monroe St., Archt. will receive bids about April 26 for the construction of a 9 story hotel at Clarendon Ave. and Gordon Terrace. F. Randall, 160 North La Salle St., is engineer.

Ill., Decatur—City, J. J. Heger, Clk., will soon receive new bids for the installation of two 625 kw. steam turbine generators with exciters, 2 panel switchboard and two 1250 ft. surface condensers in power plant. Former bids rejected. This corrects report in Mar. 9 issue.

Ill., Decatur—Decatur & Macon County Hospital, P. W. Wipperman, Supt., North Edward St., will soon receive bids for the construction of a power plant for hospital. Estimated cost $150,000. S. R. Lewis, 407 South Dearborn St., Chicago, is consulting engineer.

Ill., Highland Park—Highland Park Ice Co., 5538 Lake Park Blvd., awarded contract for the construction of an ice manufacturing plant to W. W. Steele, 814 Oak St.

Ill., Niles Center—Sanitary District, 910 South Michigan Ave., Chicago, will receive bids about May 10 for the construction of a 6 story office and stores building on Howard St. for North Side plant here. Estimated cost $1,250,000.

Ind., Andrews—Wasmuth-Endicott, plans the installation of two 150 hp. boilers, etc. Estimated cost $15,000.

Ind., Muncie—Kuhner Packing Co., 13th and Whitley Sts., had plans prepared for the construction of a cold storage plant. Estimated cost $150,000. Private plans.

Ia., Dubuque—City will receive bids in April for improvements to water and light plant. Estimated cost $85,000. Burns & McDonnell, Interstate Bldg., Kansas City, Mo., are engineers.

La., New Orleans—Bd. of Port Commissioners, will receive bids until April 20 for furnishing and installing 8 ball bearing electric motors, 15 to 40 hp. each for Marine Log Unloader, at Stuyvesant Docks.

Mass., Holyoke—Gas House Dept., is having plans prepared for the construction of a boiler house. Estimated cost $40,000. McClintock & Craig, 458 Bridge St., Springfield, are engineers.

Mich., Detroit—Detroit Hotel Co., 30 West Elizabeth St., awarded contract for the construction of a 20 story hotel at Baglew and Cass Aves. to Lundoff-Bicknell Co., B. F. Keith Bldg., Cleveland, O. Estimated cost $3,500,000. Steam heating system will be installed.

Mich., Mackinaw—Village, A. M. Buhler, Clk., will receive bids until April 16 for the construction of a portion of a waterworks system including one 300 g.p.m. general service centrifugal pump direct connected to electric motor, one 300 or 500 g.p.m. auxiliary service centrifugal pump direct connected to gasoline engine, 50,000 gal. tank on 85 to 100 ft. tower, etc. G. W. Clark, Muskegon, is consulting engineer.

Mich., Saginaw—City is having preliminary plans prepared for the construction of a filtration plant and pumping station. Maury & Gordon, 53 West Jackson Blvd., Chicago, Ill. and Hoad, Decker, Shoecraft & Drury, Ann Arbor, Mich., are engineers.

Mich., Ypsilanti—Ford Motor Co., Highland Park, (Detroit, P. O.) plans the construction of a 4,600 hp. hydro-electric power plant including dam 34 ft. high to impound lake about ½ mile wide, also plans an auxiliary steam power plant to serve as a reserve unit in connection with hydro-electric plant here. Private plans.

Minn., Wanamingo—Village will receive bids until March 22 for the construction of a waterworks system including pump house, pumping equipment, 10,000 gal. tank on 100 ft. tower, etc. Estimated cost $20,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Ia., are engineers.

Mo., Kansas City—St. Marys Hospital, is having plans prepared for the construction of a complete power plant for heating and ventilating. Estimated cost $85,000. Burns & McDonnell, Interstate Bldg., are engineers.

Mo., Marshall—City is having preliminary plans prepared for a water tower tank, electric pumping equipment, etc. Estimated cost $20,000.

Neb., North Platte—Bureau of Reclamation, Dept. of Interior, Denver, Colo., will receive bids until April 20 for furnishing and installing one hydraulic turbine to deliver 3,400 hp. when operating at a head of 65 ft., one 3,000 kva. generator, four 1,000 and four 375 kva. transformers, switching apparatus, two 33,000 v. lightning arresters, oil circuit breakers, air break switches, six 33,000 v. choke coils, etc. for Guernsey power plant, North Platte Project, Nebraska-Wyoming.

N. J., Newark—Arena & Amusement Co. Inc., c/o H. Harris, Chamber of Commerce Bldg., Archt., is having plans prepared for the construction of a 30 story auditorium and office building on Canal St Estimated cost $4,000,000.

N. J., Trenton — Mercer County Freeholders, W. C. Fowler, Clk, plan the construction of a 50,000 gal. tank, and installation of a new pump in Mercer County Workhouse, Moore's Station. Estimated cost $10,000. F. C. Carstarphen, 901 Edgewood Ave., is engineer.

N. Y., Albany—Metropolitan Realty Co., c/o C. H. Crane, 345 Madison Ave., New York, Archt., is having plans prepared for the construction of a hotel and stores building at State and Lodge Sts. Estimated cost $4,000,000.

N. Y., Albany—J. P. Sewall, 378 Morris Ave., is having plans prepared for the construction of a 7 story apartment on Hudson Ave. Estimated cost $850,000. W. McCullough, 25 West 44th St., New York, is architect.

N. Y., Buffalo—Millard Fillmore Hospital, Lafayette Ave., plans the construction of a hospital including power plant, etc. Estimated cost $1,000,000.

N. Y., Hamburg—Village, is having preliminary plans prepared for the construction of a 2,000,000 g.p.m. filtration plant including heating plant, boiler, pump, motor, etc. Estimated cost $148,000. Engineer not announced.

N. Y., New York—Caughey & Evans, 29 West 34th St., Archts., are preparing plans for the construction of a 13 story apartment on West 58th St. Estimated cost $800,000. Owner's name withheld.

N. Y., New York—Federation for the Support of Jewish Philanthropic Societies, c/o Buchman & Kahn, 49 West 45th St., Archts., is having plans prepared for the construction of a 17 story office building at 67-71 West 47th St.

N. Y., New York—A. Kosofskey, c/o Hudson Bay Fur Co., 662 6th Ave., is having plans prepared for the construction of a 26 story hotel at 6th Ave. and 46th St. Estimated cost $1,000,000. F. P. Platt & Bro., 221 West 57th St., are architects.

N. Y., New York—Manger Hotel, Inc., 7th Ave. and 38th St., awarded contract for the construction of a 20 story addition to hotel at 7th Ave. between 50th and 51st Sts., o Bing & Bing, Inc., 119 West 40th St.

N. Y., New York—One Hundred University Avenue Corp., c/o Gronenberg & Leuchtag, 450 4th Ave., Archts. and Engrs., is having plans prepared for the construction of a 15 story apartment at 9 East 96th St.

N. Y., Syracuse—Syracuse Post Standard, will soon award contract for the construction of an office building. Estimated cost $1,000,000. M. L. King, Denison Bldg., is architect.

N. Y., Yonkers—J. E. Andrus, c/o G. W. Lamb, 644 8th Ave., New York, Archt., will soon receive bids for the construction of a theatre and office building on South Broadway here. Estimated cost $1,000,000. R. D. Kimball, 15 West 38th St., New York, is engineer.

N. C., Coleridge—Enterprise Mfg. Co., plans extensions to cotton mill including heating and power plants, etc. on Deep River. Estimated cost $50,000. Lockwood Greene & Co., Piermont Bldg., Charlotte, are engineers.

N. C., Greensboro—Greensboro Bank & Trust Co., plans the construction of a 12 story bank and office building on Elm St. Estimated cost $1,000,000. C. C. Hartmann, is architect.

N. C., Monroe—V. Funderburk, Mayor and Bd. of Commissioners, will receive bids until April 6 for improvements to waterworks including complete water purification plant, raw water pumping station, sewage pump station, etc. G. H. Bishop, Consit. Engr. and The Carolina Engineering Co., 917 Johnston Bldg., Charlotte, are engineers.

O., Cleveland—The Otis Steel Co., L. C. Pratt, Purch. Agt., 3341 Jennings Road, is in the market for one 10,000 kw. turbine and generator, three 10,000 gal. pumps and two 800 hp. boilers. W. F. Hilditch, Engr.

O., Cleveland—Park Hall Co., awarded contract for the construction of a 6 story hotel on Ansel Road to N. Weltman, 3320 Ormond Road, Cleveland Heights. Estimated cost $600,000. Steam heating system will be installed.

Pa., Allentown—A. Palruch & A. Gomery, will receive bids until March 30 for the construction of a 10 story hotel at Sixth and Hamilton Sts. Estimated cost $1,250,000. Ritter & Shay, Packard Bldg., Philadelphia, are architects.

Pa., Lake Charles—Lake Charles Rice Milling Co. of Louisiana, J. A. Foster, Pres., awarded contract for the construction of a 5 story rice mill, 4800 bbls. daily capacity including boiler house and engine room, etc. to P. Olivier & Son. Estimated cost $500,000.

Tex., Amarillo—Metzger Bros., c/o C. Metzger, Holmes Street Road, Dallas, is having plans prepared for the construction of a creamery here. F. J. Woerner & Co., 503 Central Bank Bldg., Dallas, are architects and engineers. Cold storage and refrigeration machinery will be required.

Tex., Brownsville—Bd. of Education, is having preliminary plans prepared for the construction of a power plant for the high school buildings. Estimated cost $25,000. H. P. Smith, National Bank of Commerce Bldg., San Antonio, is engineer. Equipment will be required.

Tex., Coleman—Prairie Pipe Line Co., is having plans prepared for the construction of the following projects: large pumping plant in Dibrell oil field; dam on Ranch Creek River to be used for power; pipe line extending from Pioneer to here. Total estimated cost $600,000. Private plans.

Tex., Goliad—Texas Central Power Co., Frost Bldg., San Antonio, has acquired light and ice plants here and plans improvements including new machinery, etc. to increase the capacity. Estimated cost $40,000. Private plans.

Tex., La Porte—City, F. W. Reynolds, Mayor, will receive bids until March 29 for drilling and completion of an 8 in. water well with pumping equipment and innstallation of a 50,000 gal. steel tank and distribution system. D. M. Duller, 1618 Second National Bank Bldg., Houston, is consulting engineer.

Tex., Newton—J. I. Miller Jr. & Associates, is having preliminary plans prepared for the construction of water, ice and electric plants. Total estimated cost $100,000. Private plans.

Tex., San Antonio—H. B. Rouse & Co., 2214 Ward St., Chicago, Ill., is having preliminary surveys made for the construction of a 12 story hotel including swimming pool, etc. here. Estimated cost $1,000,000. Private plans.

Tex., Sour Lake—Western Public Service Co., J. G. Holtzclaw, Mgr., plans reconditioning ice plant, including new ice vault, ammonia condensers, changing freezing system from distilled to raw water ice. Estimated cost $35,000. Private plans. Owner will purchase equipment.

Va., New Market—G. A. Woods, Mayor and Town Council will receive bids until March 30 for the construction of water supply and sewage systems including dam, fire pump house and pump, 2 sewage pumps, etc. The American Industries Engineering Co., 140 Cedar St., New York, N. Y., and The Carolina Engineering Co., 917 Johnston Bldg., Charlotte, N. C., are engineers.

Wash., Seattle—C. Linde, Seaboard Bldg., Archt., will receive bids about July 1 for the construction of a 12 story hotel at Ninth and Pine Sts. Estimated cost $1,500,000. Owner's name withheld.

Wash., Shelton—City is having plans prepared for the construction of a waterworks system including the installation of a 750 g.p.m. pump, 50,000 gal. tank or reservoir. Estimated cost $48,000. E. C. Manning, is engineer.

Wis., Beloit—Beloit Water, Gas & Electric Co., A. Dobson, Mgr., is having plans prepared for the drilling of a well, 2,000,000 gal. capacity, also the installation of a 1,000 g.p.m. pump. Estimated cost $25,000. Mead & Seastone, Journal Bldg., Madison, are engineers.

Wis., Milwaukee—Schroeder Hotel Co., 86 Michigan St., is having preliminary plans prepared for the construction of a 17 story hotel at Fifth St. and Grand Ave. Estimated cost $4,000,000. Holabird & Roche, 104 South Michigan Blvd., Chicago, Ill., are architects.

Wis., Wauwatosa — Milwaukee County, N. O. P. Franke, Chn., 4419 North Ave., Milwaukee, plans the construction of a hospital on Grand Ave. Estimated cost $1,100,000. Also plans an emergency hospital and dispensary at 24th St. and Grand Ave. here. Architect not selected.

Ont., Toronto—Federal Building Corp., 85 Richmond St. W., plans the construction of an 11 story office building including steam heating and vacuum systems at Bay and Albert Sts. Estimated cost $500,000. Architect and engineer not selected.

Ont., Windsor—Waterworks Commission, H. A. Hanrahan, Secy., City Hall, wants prices and data on a 12,000,000 g.p.d., 175 ft. total lift centrifugal pump, both motor and condensing steam turbine drive.